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Attorneys for Plaintiff
THE CALIFORNIA SPORTFISHING
PROTECTION ALLIANCE

UNITED STATES DISTRICT COURT

EASTERN DISTRICT OF CALIFORNIA

THE CALIFORNIA SPORTFISHING PROTECTION ALLIANCE, a California nonprofit corporation, Plaintiff, vs. Tri C Manufacturing, Inc., a California corporation, Defendant.	Case No. 2:20-cv-00037-TLN-EFB [PROPOSED] CONSENT DECREE (Federal Water Pollution Control Act, 33 U.S.C. §§ 1251 to 1387)

CONSENT DECREE

The following Consent Decree is entered into by and between Plaintiff The California Sportfishing Protection Alliance ("Plaintiff" or "CSPA") and Defendant Tri C Manufacturing, Inc. ("Defendant" or "Tri-C"). The entities entering into this Consent Decree are each an individual "Settling Party" and collectively the "Settling Parties" or "Parties."

WHEREAS, CSPA is a 501(c)(3) non-profit, public benefit corporation duly organized and existing under the laws of the State of California, dedicated to the protection, enhancement, and restoration of the Sacramento River, its tributaries, and other California waters;

WHEREAS, Tri-C is the owner and operator of a facility located at 520 Harbor Boulevard in West Sacramento, California that recycles used tires and manufactures equipment to shred and sort tires, among other activities (the "Facility");

WHEREAS, the Facility falls within Standard Industrial Classification ("SIC") codes 5093 (Scrap and Waste Materials) and 3559 (special industrial machinery, NEC);

WHEREAS, storm water discharges associated with industrial activity at the Facility are regulated pursuant to the National Pollutant Discharge Elimination System ("NPDES") General Permit No. CAS000001 [State Water Resources Control Board], Water Quality Order No. 92-12-DWQ (as amended by Water Quality Order 97-03-DWQ and as subsequently amended by Water Quality Order No. 2014-0057-DWQ) (hereinafter the "Permit"), issued pursuant to Section 402 of the Federal Water Pollution Control Act ("Clean Water Act" or "the Act"), 33 U.S.C. §§ 1251 *et seq.*;

WHEREAS, the Permit includes the following requirements for all permittees, including Tri-C: 1) develop and implement a storm water pollution prevention plan

("SWPPP"); 2) control pollutant discharges using best available technology economically achievable ("BAT") and best conventional pollutant control technology ("BCT") to prevent or reduce pollutants; 3) implement BAT and BCT through the development and application of Best Management Practices ("BMPs"), which must be included and updated in the SWPPP; and 4) when necessary, implement additional BMPs to prevent or reduce any pollutants that are causing or contributing to any exceedance of water quality standards;

WHEREAS, on October 8, 2019 CSPA served Tri-C, the Administrator of the United States Environmental Protection Agency ("EPA"), the Executive Director of the State Water Resources Control Board ("State Board"), the Executive Officer of Regional Water Quality Control Board, Central Valley ("Regional Board"), the U.S. Attorney General, and the Regional Administrator of the EPA (Region 9) with a notice of intent to file suit under Sections 505(a)(1) and (f) of the Clean Water Act, 33 U.S.C. § 1365(b)(1)(A) ("60-Day Notice Letter"), alleging violations of the Act and the Permit at the Facility;

WHEREAS, on January 6, 2020, CSPA filed a complaint against Tri-C in the United States District Court, Central District Court of California, entitled *California Sportfishing Protection Alliance v. Tri C Manufacturing, Inc.* (Case No. 2:20-cv-00037-TLN-EFB); alleging violations of Section 301(a) of the Clean Water Act, 33 U.S.C. § 1311(a), and violations of the Permit at the Facility ("Complaint") based on the 60-Day Notice Letter;

WHEREAS, CSPA contends in its 60-Day Notice Letter and Complaint that, among other things, Tri-C has repeatedly discharged polluted storm water in violation of the Permit and the Clean Water Act;

WHEREAS, Tri-C denies all allegations set forth in the 60-Day Notice Letter

and Complaint relating to the Facility;

WHEREAS, the Settling Parties, through their authorized representatives and without either adjudication of CSPA's claims or any admission by Tri-C of any alleged violation or other wrongdoing, believe it is in their mutual interest to resolve in full CSPA's allegations in the 60-Day Notice Letter and Complaint through settlement and avoid the cost and uncertainties of further litigation;

NOW THEREFORE IT IS HEREBY STIPULATED BETWEEN THE SETTLING PARTIES, AND ORDERED AND DECREED BY THE COURT, AS FOLLOWS:

1. The Court has jurisdiction over the subject matter of this action pursuant to Section 505(a)(l)(A) of the Clean Water Act, 33 U.S.C. § 1365(a)(1)(A);

2. Venue is appropriate in the Eastern District of California pursuant to Section 505(c)(l) of the Clean Water Act, 33 U.S.C. § 1365(c)(1), because the Facility at which the alleged violations took place is located within this District;

3. The Complaint states claims upon which relief may be granted pursuant to Section 505(a)(l) of the Clean Water Act, 33 U.S.C. § 1365(a)(1);

4. Plaintiff has standing to bring this action;

5. The Court shall retain jurisdiction over this matter for purposes of enforcing the terms of this Consent Decree for the life of the Consent Decree, or as long thereafter as is necessary for the Court to resolve any motion to enforce this Consent Decree.

I. OBJECTIVES

6. It is the express purpose of the Settling Parties entering into this Consent Decree to further the objectives set forth in the Clean Water Act, 33 U.S.C. §§ 1251, *et seq.*, and to resolve those issues alleged by CSPA in its Complaint. In light of these

objectives and as set forth fully below, Defendant agrees to comply with the provisions of this Consent Decree and to comply with the requirements of the Permit and all applicable provisions of the Clean Water Act at the Facility.

II. COMMITMENTS OF TRI-C

7. In order to reduce or prevent pollutants associated with industrial activity from discharging via storm water to the waters of the United States, Tri-C shall implement appropriate structural and non-structural BMPs, as required by the Permit, as described more fully below.

8. **Maintenance of Implemented Storm Water Controls.** Tri-C agrees that the Facility shall maintain in good working order all storm water collection and management systems currently installed or to be installed pursuant to this Consent Decree, including but not limited to, existing housekeeping measures.

9. **Structural Improvements to Storm Water Management Measures.** Unless otherwise indicated in paragraph 25, Tri-C shall implement the below structural best management practices to improve storm water management at the Facility. Given the business and other uncertainties related to the current COVID-19 crisis and the potential sale and assignment of the business, Tri-C shall use its best efforts to implement the following structural BMPs by October 1, 2020, but, shall in any event implement each of the following BMPs at the Facility by no later than January 1, 2021:

a. **Storm Water Treatment System.** Tri-C shall install and maintain Phase 1 of the treatment system ("Phase 1 Treatment System") described in the Frog Environmental/Storm Proof "Storm Water Treatment System Description and Sizing Tri-C Manufacturing" dated July 15, 2020 (the "Proposal"), attached hereto as Exhibit A. Installation of the Phase 1 Treatment System shall include

Facility site upgrades to redirect storm water flow form discharge points DP#1, DP#2, and DP#3 to a single discharge location where the Phase 1 Treatment System will be located. The Phase 1 Treatment System shall be designed to store, and prevent bypass, during peak discharges for storms at least double the 85th percentile hourly intensity, and to treat an 85th percentile 24-hour storm volume for drainage areas 1, 2, and 3, as identified on the Facility's SWPPP map, attached hereto as Exhibit B. The Phase 1 Treatment System will be designed to handle and treat without bypass, at a minimum, the maximum flow rate of runoff produced by the 85th percentile hourly rainfall intensity, as determined from local historical rainfall records, and store double the discharge from an 85th percentile storm, in accordance with the General Permit. When combined with the Phase 1 Treatment System's drop inlets, pumps, clarifiers, and other elements of the Phase 1 Treatment System, the capacity based on this rate is 50 gallons per minute ("gpm") for Drainage Areas DP#1, DP#2 and DP#3 The Treatment System shall be designed to achieve reduction of pollutant levels below NALs.

b. Prior to installation, the design of the Treatment System must be approved by a qualified Professional Engineer.

c. Tri-C shall notify CSPA of any bypass of the treatment system that occurs from runoff during or following a rain event.

d. Within ten (10) days of the installation of the Phase 1 Treatment System, Tri-C shall provide CSPA with a written report certifying that it has completed installation and containing digital photographs of the installed measures.

10. **Exposure Minimization BMPs.** By September 1, 2020, Tri-C shall implement the following exposure minimization BMPs at the Facility:

a. To prevent rainfall from coming into contact with ground rubber

and metal debris stored in the bunkers on the western edge of the 520 Harbor Parcel, as depicted in Exhibit B, Tri-C shall install the necessary infrastructure to facilitate a temporary covering over the bunkers that will be mobilized for all ongoing storm events.

b. To prevent rainfall from coming into contact with dust and particulate generated from the Facility's outdoor classifier unit , Tri-C shall install covers over the classifier section of the processing line located on the south side of the Indoor Production building, as depicted in Exhibit B.

11. **Improvements to Housekeeping Measures at the Facility. By** September 1, 2020, Tri-C shall implement the following housekeeping procedures at the Facility:

a. Tri-C shall conduct daily sweeping of all paved areas of the Facility using a regenerative sweeper. Tri-C shall also conduct sweeping at the bunkers, depicted in Exhibit B, any time rubber crumb is loaded or unloaded from the bunkers. All sweeping activities shall be recorded in a sweeping log.

b. Tri-C shall repair all cracked pavement areas of the Facility that inhibit storm water flowing to discharge points DP#1, DP#2, or DP#3.

12. **Additional Monitoring and Sampling.** Tri-C shall conduct the following enhanced monitoring and sampling procedures.

a. **Storm Water Analysis**. Tri-C shall analyze each storm water sample taken in accordance with the General Permit and this Consent Decree for, at a minimum, pH, total suspended solids, oil and grease, iron, aluminum, and Zinc.

b. During the 2020-2021 reporting year, Tri-C shall sample and analyze

storm water discharges from, at a minimum, the first four Qualifying Storm Events ("QSEs," as defined in the General Permit), in the manner set forth in the General Permit. If the Facility's storm water sampling results from the first two QSEs during the 2020-2021 reporting year indicate that the average of the analytical results for aluminum, iron, zinc, TSS, or pH exceed the annual NALs (as set forth in the General Permit and listed below in Table 1) (a "Non-Complying Result"), Tri-C shall upgrade the Phase 1 Treatment System by installing and maintaining the carbon media upgrade described in Exhibit A as Phase 2 (the "Phase 2 Treatment System") by no later than 60-days after receipt of the Non-Complying Result. If the first two QSEs during the 2020-2021 reporting year do not demonstrate an exceedance, but the sampling results from all four QSEs during the 2020-2021 reporting year indicate that the average of the analytical results for aluminum, iron, zinc, TSS, or pH exceed the annual NALs, then Tri- shall upgrade the Phase 1 Treatment System by installing and maintaining a Phase 2 Treatment System by September 1, 2021.

c. If Tri-C is required to install the Phase 2 Treatment System pursuant to paragraph 12(b), Tri-C shall sample and analyze, at a minimum, the first four QSEs during the 2021-2022 reporting year, in the manner set forth in the General Permit. If the Facility's storm water sampling results from the first two QSEs during the 2021-2022 reporting year indicate that the average of the analytical results for aluminum, iron, zinc, TSS, or pH exceed the annual NALs (as set forth in the General

Permit and listed below in Table 1), Tri-C shall upgrade the Phase 2 Treatment System by installing and maintaining the metals media upgrade described in Exhibit A as Phase 3 (the "Phase 3 Treatment System") by no later than 60-days after receipt of the Non-Complying Result. If the first two QSEs during the 2021-2022 reporting year do not demonstrate an exceedance, but the sampling results from all four QSEs during the 2021-2022 reporting year indicate that the average of the analytical results for aluminum, iron, zinc, TSS, or pH exceed the annual NALs, then Tri- shall upgrade the Phase 2 Treatment System by installing and maintaining a Phase 3 Treatment System by September 1, 2022.

d. For purposes of this Consent Decree only, if a QSE occurs at the Facility and Tri-C fails to take a sample of that QSE or fails to have a sample from that QSE analyzed, the Parties stipulate that Tri-C shall make a payment of $2,500.00 to the Rose Foundation for Communities and the Environment pursuant to the terms described in paragraph 15, below.

e. **Monitoring Results.** Results from the Facility's sampling and analysis during the term of this Consent Decree shall be provided to CSPA within thirty (30) days of receipt of the sampling results by Tri-C or its counsel.

Table 1. Numeric Limitations.

Contaminant	**Numeric Limit**
Aluminum	0.75 mg/L

Iron	1.0 mg/L
Zinc	0.26 mg/L
Total Suspended Solids	100 mg/L
pH	6.0 – 9.0 s.u.

13. **Amendment of SWPPP.** Within thirty (30) days of the Effective Date, Tri-C shall amend the Facility's SWPPP to the extent necessary to incorporate all changes, improvements, and best management practices set forth in or resulting from this Consent Decree. Tri shall ensure that all maps, tables, and text comply with the requirements of the Permit. Specifically, the map shall depict each of the Facility's drainage areas. A copy of the amended SWPPP shall be provided to CSPA within ten (10) business days of completion.

14. **Provision of Documents and Reports.** During the term of this Consent Decree, Tri-C shall provide CSPA with a copy of all documents submitted to the Regional Board or the State Board concerning the Facility's storm water discharges, including but not limited to all documents and reports submitted to the Regional Board and/or State Board as required by the Permit. Such documents and reports shall be mailed to CSPA contemporaneously with submission to such agency. Alternatively, to the extent that Tri-C submits such documents to the Regional Board or State Board via the State Board's Stormwater Multiple Application and Report Tracking System ("SMARTS"), Tri-C may satisfy this requirement by providing notice to CSPA via e-mail that said results have been uploaded to SMARTS within seven (7) days of uploading said documents.

III. MITIGATION PAYMENT, REIMBURSEMENT OF LITIGATION FEES AND COSTS, OVERSIGHT, AND STIPULATED PAYMENTS

15. **Mitigation Payment.** In recognition of the good faith efforts by Tri-C to comply with all aspects of the General Permit and the Clean Water Act, and in lieu of payment by Tri-C of any penalties, which have been disputed but may have been assessed in this action if it had been adjudicated adverse to Tri-C, the Settling Parties agree that Tri-C will pay the sum of thirty-five thousand dollars ($35,000) to the Rose Foundation for Communities and the Environment ("Rose Foundation") for the sole purpose of providing grants to environmentally beneficial projects relating to water quality improvements in Sacramento River and Sacramento-San Joaquin Delta. Payment shall be provided to the Rose Foundation as follows: Rose Foundation, 201 4th Street, Suite 102, Oakland, CA 94607, Attn: Tim Little. Payment shall be made by Tri-C to the Rose Foundation within one-hundred-twenty (120) calendar days of the Effective Date. Tri-C shall copy CSPA with any correspondence and a copy of the check sent to the Rose Foundation. The Rose Foundation shall provide notice to the Settling Parties within thirty (30) days of when the funds are disbursed by the Rose Foundation, setting forth the recipient(s) and purpose(s) of the funds.

16. **Reimbursement of Fees and Costs.** Tri-C shall reimburse CSPA in the amount of thirty-six thousand five hundred dollars ($36,500.00) to help defray CSPA's reasonable investigation, expert, and attorneys' fees and costs, and all other reasonable costs incurred as a result of investigating the activities at the Facility related to this Consent Decree, bringing these matters to Tri-C's attention, and negotiating a resolution of this action in the public interest. The payment shall be made within thirty (30) days of the Effective Date. The payment shall be made via

wire transfer or check, made payable to: "Lozeau Drury LLP" and delivered by overnight delivery, unless payment via wire transfer, to: Lozeau Drury LLP, c/o Rebecca Davis, 1939 Harrison St, Suite 150, Oakland, CA 94612.

17. **Compliance Monitoring Funds.** As reimbursement for CSPA's future fees and costs that will be incurred in order for CSPA to monitor Tri-C's compliance with this Consent Decree and to effectively meet and confer and evaluate storm water monitoring results for the Facility, Tri-C agrees to pay CSPA the additional sum of three thousand dollars ($3,000) per Reporting Year. Payment will be made within 30 days of the Effective Date in the manner prescribed for the payment required by paragraph 22.

IV. COMMITMENT OF CSPA

18. **Submission of Consent Decree to DOJ.** Within three (3) business days of receiving all of the Settling Parties' signatures to this Consent Decree, CSPA shall submit this Consent Decree to the U.S. Department of Justice ("DOJ") and EPA for agency review consistent with 40 C.F.R. §135.5. The agency review period expires forty-five (45) calendar days after receipt by the DOJ, evidenced by correspondence from DOJ establishing the review period. If for any reason the DOJ or the District Court should decline to approve this Consent Decree in the form presented, the Parties shall use their best efforts to work together to modify the Consent Decree within thirty (30) days so that it is acceptable to the DOJ or the District Court. If the Parties are unable to modify this Consent Decree in a mutually acceptable manner that is also acceptable to the District Court, this Consent Decree shall immediately be null and void as well as inadmissible as a settlement communication under Federal Rule of Evidence 408 and California Evidence Code section 1152.

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V. WAIVER, RELEASES AND COVENANTS NOT TO SUE

19. In consideration of the above, and except as otherwise provided by this Consent Decree, the Parties hereby forever and fully release each other and their respective parents, affiliates, subsidiaries, divisions, insurers, successors, assigns, and current and former employees, attorneys, officers, directors and agents from any and all claims and demands of any kind, nature, or description whatsoever, and from any and all liabilities, damages, injuries, actions or causes of action, either at law or in equity, which the Parties have against each other arising from CSPA's allegations and claims as set forth, or as could have been set forth, in the 60-Day Notice Letter and Complaint for any and all violations of the Permit or the Clean Water Act at the Facility up to and including the Termination Date of this Consent Decree.

20. **No Admission.** The Parties enter into this Consent Decree for the purpose of avoiding prolonged and costly litigation. Nothing in this Consent Decree shall be construed as, and Tri-C expressly does not intend to imply, any admission as to any fact, finding, issue of law, or violation of law, nor shall compliance with this Consent Decree constitute or be construed as an admission by Tri-C of any fact, finding, conclusion, issue of law, or violation of law. However, this Paragraph shall not diminish or otherwise affect the obligation, responsibilities, and duties of the Parties under this Consent Decree.

VI. BREACH OF CONSENT DECREE AND DISPUTE RESOLUTION PROCEDURES

21. **Informal Dispute Resolution**. The Settling Parties will engage in "Informal Dispute Resolution" pursuant to the terms of this paragraph:

a. If a dispute under this Agreement arises, including whether any Settling Party believes that a violation of the Agreement and the Court's dismissal order has occurred, the Settling Parties will meet

and confer (telephonically or in-person) within twenty-one (21) days of receiving written notification of a request for such meeting, unless the parties have already met and conferred on the dispute pursuant to paragraph 17. During the meet and confer proceeding, the Settling Parties will discuss the dispute and make reasonable efforts to devise a mutually acceptable plan, including implementation dates, to resolve the dispute. The Settling Parties may, upon mutual written agreement, extend the time to conduct the meet and confer discussions beyond twenty-one (21) days. If meet and confer discussions fail to resolve the dispute, the Settling Parties shall request a magistrate judge of this court to conduct a single mediation session pursuant to such procedures as the magistrate judge may require. The mediation is to be held within 45 days of the conclusion of the meet and confer discussions, or as soon thereafter as the schedule of the magistrate judge will permit.

b. If any Settling Party fails to meet and confer or mediate within the timeframes set forth in paragraph (a) directly above, or the meet and confer and mediation do not resolve the dispute, after at least twenty-one (21) days have passed after the meet and confer or mediation occurred or should have occurred, either Settling Party may initiate the "Formal Dispute Resolution" procedures outlined directly below.

22. **Formal Dispute Resolution.** In any action or proceeding which is brought by any Settling Party against any other Settling Party pertaining to, arising out of, or related to the requirements of the Court's dismissal order and this Agreement, the Settling Parties will first utilize the "Informal Dispute Resolution" proceedings set

forth in the preceding paragraph and, if not successful, the Settling Parties will utilize the "Formal Dispute Resolution" procedures in this paragraph. "Formal Dispute Resolution" will be initiated by filing a Motion to Show Cause or other appropriately titled motion ("Motion") in the United States District Court, Eastern District of California, to determine whether either party is in violation of the Agreement and the Court's dismissal order and, if so, to require the violating party to remedy any violation identified by the District Court within a reasonable time frame. Litigation costs and fees incurred in the Formal Dispute Resolution process will be awarded in accord with the standard established by Section 505 of the Clean Water Act, 33 U.S.C. § 1365.

VII. MISCELLANEOUS PROVISIONS

23. **Effective Date.** The Effective Date of this Consent Decree shall be upon the subsequent entry of the Consent Decree by the Court.

24. **Term of Consent Decree.** If no Phase 2 Treatment System is required pursuant to paragraph 12(b), this Consent Decree shall terminate on the 30th day following notice to CSPA of the fourth QSE following installation of the Phase 1 Treatment System, indicating that no Phase 2 Treatment System is required ("Termination Date 1"). If a Phase 2 Treatment System is required pursuant to paragraph 12(b), but no Phase 3 Treatment System is required pursuant to paragraph 12(c), this Consent Decree shall terminate on the 30th day following notice to CSPA of the fourth QSE following installation of the Phase 2 Treatment System, indicating that no Phase 3 Treatment System is required ("Termination Date 2"). If a Phase 3 Treatment System is required pursuant to paragraph 12(c), this Consent Decree shall terminate on the 30th day following notice to CSPA of installation of the Phase 3 Treatment System ("Termination Date 3"). This Consent Decree shall continue in effect from the Effective Date until Termination Date 1, Termination Date 2, or

Termination Date 3 (whichever is applicable pursuant to this Consent Decree), or until early termination pursuant to paragraph 25, or through the conclusion of any proceeding to enforce this Consent Decree initiated prior to the applicable termination date, or until the completion of any payment or affirmative duty required by this Consent Decree, whichever is the later occurrence.

25. **Early Termination**. If Tri-C should cease industrial operations at the Facility and file a Notice of Termination ("NOT") under the Industrial Stormwater Permit prior to the Termination Date(s) of this Consent Decree, Tri-C shall send CSPA a copy of the proposed NOT concurrent with its submittal to the Regional Water Board. Within ten (10) days of the Regional Water Board's approval of the NOT, Tri-C shall notify CSPA in writing of the approval and remit all outstanding payments, including stipulated payments pursuant to paragraph 12(d), to CSPA. This Consent Decree shall terminate upon notice to CSPA of the NOT and payment of all outstanding payments. In the event a new successor or assign continues industrial operations at the site and assumes responsibility for implementation of this Consent Decree pursuant to paragraph 36, Tri-C shall notify CSPA within ten (10) days of the transition.

26. **Execution in Counterparts.** The Consent Decree may be executed in one or more counterparts which, taken together, shall be deemed to constitute one and the same document.

27. **Facsimile Signatures.** The Parties' signatures to this Consent Decree transmitted by facsimile or electronic mail transmission shall be deemed binding.

28. **Construction.** The language in all parts of this Consent Decree, unless otherwise stated, shall be construed according to its plain and ordinary meaning. The captions and paragraph headings used in this Consent Decree are for reference only

and shall not affect the construction of this Consent Decree.

29. **Authority to Sign.** The undersigned are authorized to execute this Consent Decree on behalf of their respective parties and have read, understood and agreed to all of the terms and conditions of this Consent Decree.

30. **Integrated Consent Decree.** All Consent Decrees, covenants, representations and warranties, express or implied, oral or written, of the Parties concerning the subject matter of this Consent Decree are contained herein.

31. **Severability.** In the event that any of the provisions of this Consent Decree are held by a court to be unenforceable, the validity of the enforceable provisions shall not be adversely affected.

32. **Choice of Law.** This Consent Decree shall be governed by the laws of the United States, and where applicable, the laws of the State of California.

33. **Full Settlement.** This Consent Decree constitutes a full and final settlement of this matter. It is expressly understood and agreed that the Consent Decree has been freely and voluntarily entered into by the Parties with and upon advice of counsel.

34. **Negotiated Consent Decree.** The Parties have negotiated this Consent Decree, and agree that it shall not be construed against the party preparing it, but shall be construed as if the Parties jointly prepared this Consent Decree, and any uncertainty and ambiguity shall not be interpreted against any one party.

35. **Modification of the Consent Decree.** This Consent Decree, and any provisions herein, may not be changed, waived, or discharged unless by a written instrument signed by the Parties.

36. **Assignment.** Subject only to the express restrictions contained in this Consent Decree, all of the rights, duties and obligations contained in this Consent

Decree shall inure to the benefit of and be binding upon the Parties, and their successors and assigns. In the event that Tri-C sells all or a portion of its business to another person or entity, Tri-C shall provide CSPA with the name and contact information for the purchasing party within ten (10) days of the sale.

37. **Mailing of Documents to CSPA/Notices/Correspondence.** Any notices or documents required or provided for by this Consent Decree or related thereto that are to be provided to CSPA pursuant to this Consent Decree shall be, to the extent feasible, sent via electronic mail transmission to the e-mail addresses listed below or, if electronic mail transmission is not feasible, via certified U.S. Mail with return receipt, or by hand delivery to the following address:

Rebecca Davis
Lozeau Drury LLP
1939 Harrison St., Suite 150
Oakland, CA 94612
E-mail: rebecca@lozeaudrury.com

Unless requested otherwise by Tri-C, any notices or documents required or provided for by this Consent Decree or related thereto that are to be provided to Tri-C pursuant to this Consent Decree shall, to the extent feasible, be provided by electronic mail transmission to the e-mail addresses listed below, or, if electronic mail transmission is not feasible, by certified U.S. Mail with return receipt, or by hand delivery to the addresses below:

W. Lee Smith
Michel and Associates, P.C.
180 E. Ocean Blvd., Suite 200
Long Beach, CA 90802

Notifications of communications shall be deemed submitted on the date that they are emailed, or postmarked and sent by first-class mail or deposited with an

overnight mail/delivery service. Any changes of address or addressees shall be communicated in the manner described above for giving notices.

38. The settling Parties hereto enter into this Consent Decree, Order and Final Judgment and submit it to the Court for its approval and entry as a final judgment.

Date: 1 August 2020, 2020

CALIFORNIA SPORTFISHING PROTECTION ALLIANCE

Bill Jennings

William Jennings
Executive Director

Date: ________________, 2020

TRI C MANUFACTURING, INC.

____

L. Clyde Lamar, Sr.

Approved as to form:

Date: Aug. 3, 2020

LOZEAU DRURY LLP

Rebecca L. Davis
Attorneys for California Sportfishing Protection Alliance

Date: ________________, 2020

MICHEL & ASSOCIATES, P.C.

____

W. Lee Smith
Attorney for Tri-C Manufacturing, Inc.

overnight mail/delivery service. Any changes of address or addressees shall be communicated in the manner described above for giving notices.

38. The settling Parties hereto enter into this Consent Decree, Order and Final Judgment and submit it to the Court for its approval and entry as a final judgment.

Date: _______________, 2020

CALIFORNIA SPORTFISHING PROTECTION ALLIANCE

____
William Jennings
Executive Director

Date: 7/30, 2020

TRI C MANUFACTURING, INC.

____
L. Clyde Lamar, Sr.

Approved as to form:

Date: _______________, 2020

LOZEAU DRURY LLP

____
Rebecca L. Davis
Attorneys for California Sportfishing Protection Alliance

Date: 7/30, 2020

MICHEL & ASSOCIATES, P.C.

____
W. Lee Smith
Attorney for Tri-C Manufacturing, Inc.

IT IS SO ORDERED.

Date: ________________, 2020

____

Honorable Troy L. Nunley
United States District Court Judge

EXHIBIT A

YOUR CLEANER BUSINESS IS OUR ENVIRONMENT

Storm Water Treatment System Description and Sizing

Tri-C Manufacturing

520 Harbor Blvd, West Sacramento, CA 95691

July 15, 2020

Timothy Nelligan

CA Professional Engineer 68666

Principal Engineer

Table of Contents

Tri-C Manufacturing Treatment System Description & Sizing

Executive Summary

Tri-C manufacturing (Tri-C) proposes to install treatment to eliminate NAL exceedances under the General Permit for Storm Water Discharges Associated with industrial Activities (NPDES NO. CAS000001), commonly referred to as the IGP.

Tri -C Manufacturing will install a storm water treatment system comprised of the following units sized to prevent bypass during peak discharges to at least double the 85% hourly intensity, and to treat the required 85th percentile – 24 hour storm volume.

Unit Description	Size
New Storm Water Drop Inlet for Drainage Area #1 upstream of DP#1. Elimination of DP#7	One 4'x4'x5' Drop Inlets providing approximately 600 gallons volume attenuation
Sump Pump 1 to Clarifier	55 gpm
New combined Storm Water Drop Inlet for Drainage Area #2 and Drainage Area #3 upstream of DP#2 & DP#3	Two 4'x4'x5' coupled Drop Inlets providing approximately 1,200 gallons volume attenuation
Sump Pump 2 to Clarifier	105 gpm
New Storm Water Clarifier	2,000 gallons
Clarifier Sump Pump	155 gpm
Above ground storage	2,000 gallons
Treatment System	50 gpm

Facility Storm Water Construction Plan

Tri-C Manufacturing will:

1) Capture Runoff from Drainage Area #1

Install a new 4’x4’x5’ storm water drop inlet upstream of DP#1 to consolidate capture and transfer to treatment by a 55 gpm submersible pump sized for twice the runoff rate from the 85% hourly intensity.

2) Consolidate & Capture Runoff from Drainage Area#2 and Drainage Area #3

Seal drop inlet at DP#3 with a plate to prevent discharge at DP#3 redirecting the runoff to two new coupled 4’x4’x5’ storm water drop inlets upstream ofDP#2 in Drainage Area #2 to consolidate capture and transfer to treatment by 105 gpm submersible pump sized for twice the runoff rate from the 85% hourly intensity.

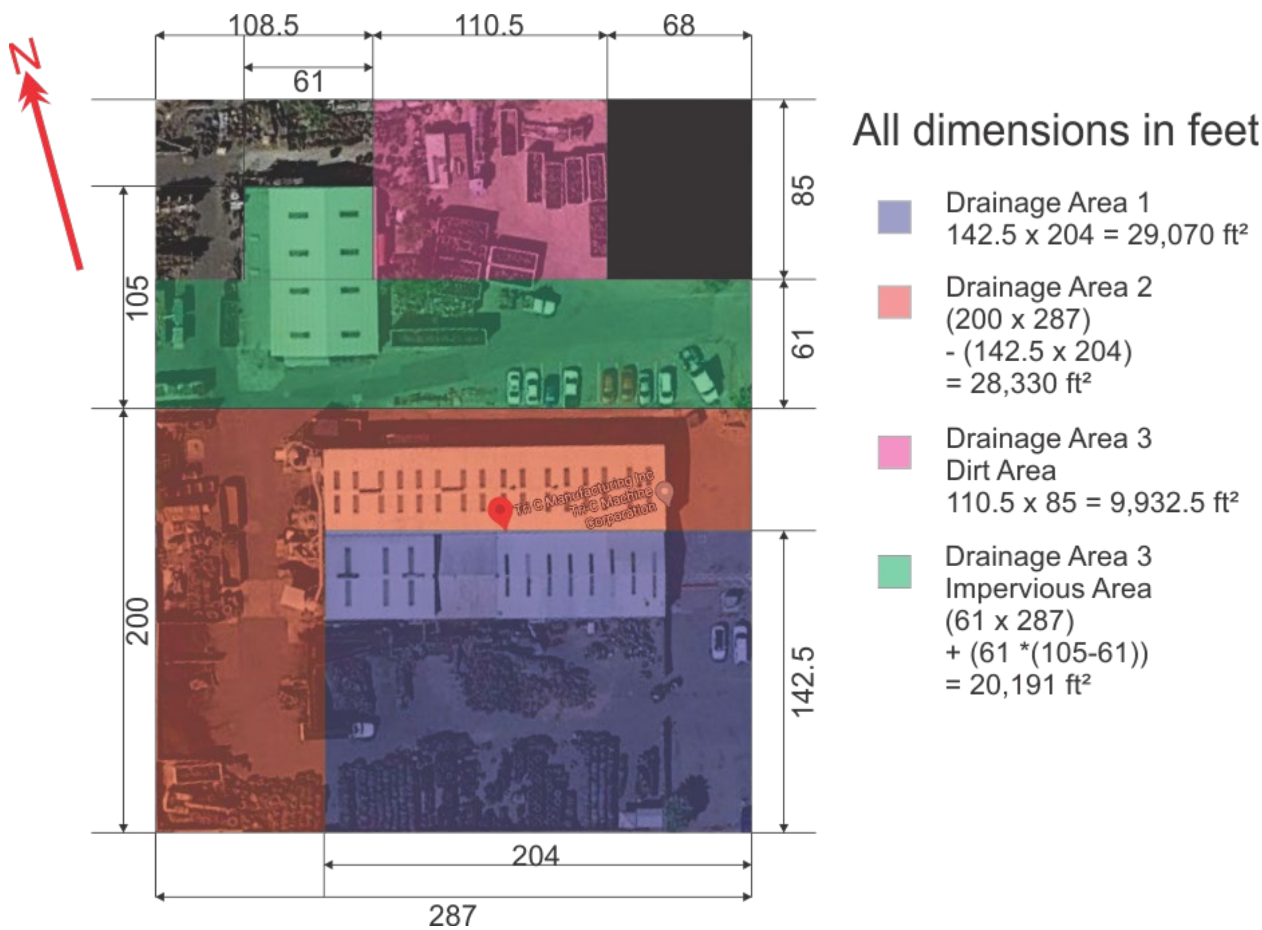
3) Install a 2,000 gallon storm water clarifier as pretreatment for the above-ground filtration system.

4) Install a 155 gpm clarifier submersible pump sized for twice the runoff rate from the 85% hourly intensity.

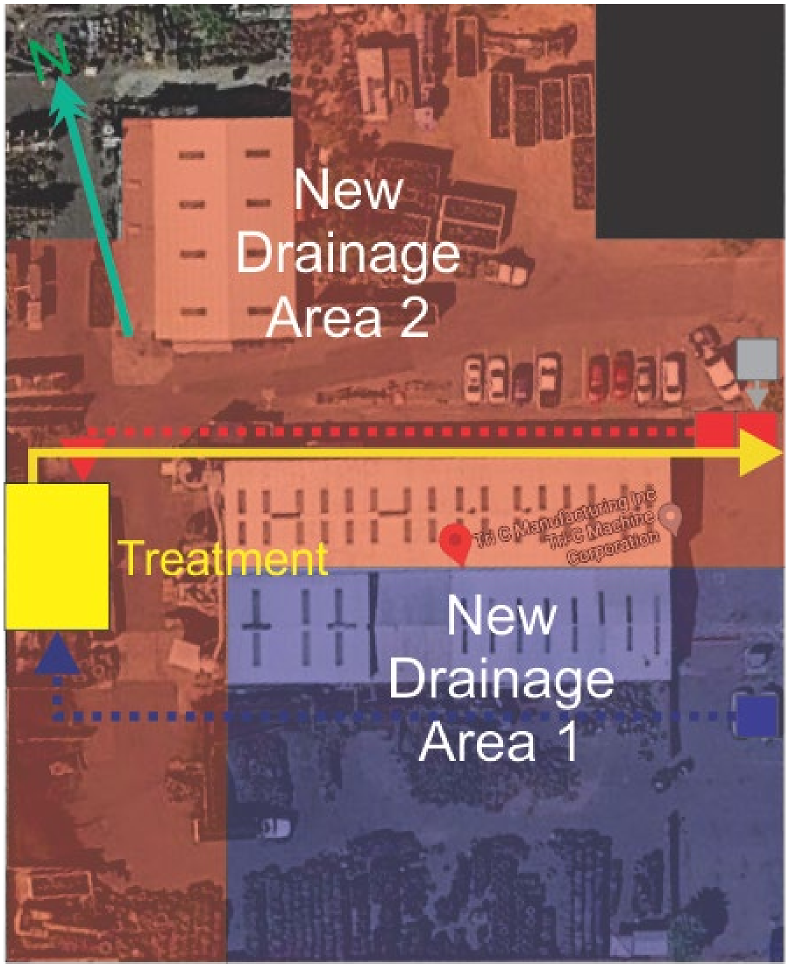
5) Install 50 gpm treatment system for the volume of the 85%-24hr storm.

The below diagram shows the existing drainage areas and their measurements.

Current Site Drainage Areas & Measurements



Plan for New Drainage Areas



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Treatment System Sizing

Basis

The proposed treatment system is designed as a Volume-Based BMP in accordance with the IGP. Specifically, it is designed to treat the volume of runoff produced from an 85th percentile 24-hour storm event, as determined from local, historical rainfall records. Storm water will be captured for treatment in excess of the IGP flow-based criteria. Specifically, the capture rate will exceed the maximum flow rate of runoff produced by the 85th percentile hourly rainfall intensity, as determined from local historical rainfall records, multiplied by a factor of two.

Rainfall Data

Rainfall data was sourced from CalTrans Basin Sizer, version 1.47. Copyright 2013 Office of Water Programs California State University Sacramento.

The 85th percentile 24-hour storm depth is 0.62 inches as determined from 65 years of data from NCDC #7630, Sacramento FAA Airport.

The 85th percentile hourly intensity is 0.092 inches / hour also determined from NCDC #7630, Sacramento FAA Airport; however, the system will be sized based on 0.2 inches.

Treatment Area

As described above, Tri-C will consolidate outfalls by pumping the captured water at two outfalls to a clarifier

Measurements of the current site drainage areas

The following table summarizes the areas to be considered for sizing as shown on the Current Site Drainage Areas & Measurements above.

Drainage Area	**Area (ft^2)**
#`1	29,070
# 2	28,330
# 3 – dirt area	9,392.5
# 3 – paved area	20,191
Total Treatment Area	86,983.5

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Runoff Coefficient

For the paved areas of the site, the runoff coefficient was estimated in accordance with CalTrans Technical White Paper CTSW-TM-15-312.03.0, “Runoff Coefficient Evaluation for Volumetric BMP Sizing.”, May 29, 2015. This white paper is included at the end of this document in the Addendums.

Urbonas (1999) proposed a third order polynomial equation to estimate C:

$C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$, where i is the impervious fraction.

For an entirely paved site such as Tri-C Manufacturing, i=1, and C=0.892.

For the dirt area, a runoff coefficient of 0.6 was selected.

Site Calculations

Example Drainage Area #1

85th % - 24 hr storm volume = C x d x A, where C is the runoff coefficient, d is the storm depth, and A the area

$V = 0.892 \times (0.62 \text{ in} / 12\text{in/ft}) \times (29{,}070 \text{ ft}^2) \times 7.48 \text{ gal/ft}^3 = 10{,}021.3$ gallons

Per the rational method, Double 85% Hourly Intensity Flow Q = 2 x C x i x A, where Q is in ft^3/s, C is the dimensionless runoff coefficient, i is the 85th percentile hourly intensity, and A the area in acres.

$Q = 2 \times 0.892 \times 0.1 \times (29{,}070 \text{ ft}^2 / 43{,}560 \text{ ft}^2/\text{acre}) = 0.361 \text{ ft}^3/\text{s} \times 60\text{s/min} \times 7.48 \text{ gal/ft}^3 = 53.4$ gpm

Drainage Area	85th % - 24 hour Volume (gal)	2 x 85th% hourly Flow (gpm)
1	10,021	53.4
2	9,766	52.1
3 – dirt area	2,178	11.6
3 – paved area	6,960	37.1
Total Area	28,926	154.2

The spreadsheet calculations tabulated above area attached at the end of this document in the Addendums.

Storm Curves & Rainfall Temporal Distributions

Storm Curve Data were taken from NOAA Atlas 14, Volume 6, Appendix A.6 Temporal distributions of annual maxima. NOAA Atlas 14, Volume 6, Appendix A.6 is included at the end of this document in the Addendum. Tri-C Manufacturing is in West Sacramento which is in Temporal Distribution Region 5. For each region, rainfall temporal distributions are provided for various storms from rains which come in heavy early as exemplified in the 10% cases, average temporal distribution in the 50% case, and rains which come in heavy late in the 90% case. The temporal distributions are provided as percentage of rainfall in ½ hour time increments for 24 hours.

Data & Plots of the above temporal distribution cases shown at the end of this report demonstrate that the limiting case is the 10% case showing rainfall heaviest early in the event.

The temporal distribution data & plots are included in the Addendums.

The 85^{th}%-24 hr rainfall depth is then applied to the 10% rainfall distribution to establish the rainfall curve which is shown in the Addendums.

Rainfall and Treatment System Discrete Dynamic Spreadsheet Simulation

From the incremental rainfall analysis, a spreadsheet simulation of the treatment dynamics is conducted. This spreadsheet simulates the runoff from the selected drainage areas, the collection and transfer by submersible pumps to the pretreatment clarifier, the by submersible pump to the above-ground storage and the flow through the system.

The system was simulated using a 55 gpm submersible pump in the drainage area 1, a 105 gpm submersible pump in the combination of drainage areas #2 & #3, a 155 gpm submersible pump in the clarifier, and a 50 gpm treatment rate.

The below table lists the maximum accumulations throughout the simulated system.

Unit	Maximum Accumulated Volume (gal)
DA#1 Collection	376
DA#2 & DA#3 Collection	709
Clarifier	1085
Above-ground Storage	1085

The spread sheet calculations summarized in the above table are shown in the Addendums.

Runoff plots from the drainage areas are included in the Addendums.

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Recommendation

To capture storm water in excess of the 85th% hourly intensity, and to treat to the 85th% - 24 hour storm volume, we recommend installing the following units.

Unit Description	Size
New Storm Water Drop Inlet for Drainage Area #1 upstream of DP#1. Elimination of DP#7	One 4'x4'x5' Drop Inlets providing approximately 600 gallons volume attenuation
Sump Pump 1 to Clarifier	55 gpm
New combined Storm Water Drop Inlet for Drainage Area #2 and Drainage Area #3 upstream of DP#2 & DP#3	Two 4'x4'x5' coupled Drop Inlets providing approximately 1,200 gallons volume attenuation
Sump Pump 2 to Clarifier	105 gpm
New Storm Water Clarifier	2,000 gallons
Clarifier Sump Pump	155 gpm
Above ground storage	2,000 gallons
Treatment System	50 gpm

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Storm Water Treatment System Process Description

The Treatment System is comprised of a phased upgrade process based upon pH, TSS, Al, FE and Zn results. The process flow diagram for the treatment system is included in the addendum at the end of this document.

Phase 1 consists of site infrastructure upgrades and Advanced Mechanical Treatment System installation.

Facility will upgrades the infrastructure necessary to consolidate storm water flow from discharge points DP#1, DP#2 and DP#3 to a centralized treatment clarifier. Flocculants are added to the storm water in the clarifier. A submersible pump lifts the water to above-ground reaction tanks. A centrifugal pump pushes the reaction tank water through an automatic backwashing sand filter followed by two bag filtration vessels to remove solids before discharging to the storm drain system. If after the first two qualifying storm event (QSE) results, the average is not under the NAL's for pH, TSS, Al, Fe or Zn, the facility will upgrade to include Phase 2 within 60 days, or If those first two QSE samples do not show an exceedance but after the first four qualifying storm event (QSE) results, the average is not under the NAL's for pH, TSS, Al, Fe or Zn, the facility will upgrade to include Phase 2 by September 1, 2021.

Phase 2 is comprised of a carbon media vessel upgrade for general water polishing. If Phase 2 is required, samples will be collected from the first four QSE's of the 2021-2022 Storm Water Year and analyzed for pH, TSS, Al, Fe & Zn. If after the first two qualifying storm event (QSE) results, the average is not under the NAL's for pH, TSS, Al, Fe or Zn, the facility will upgrade to include Phase 3 within 60 days, or If those first two QSE samples do not show an exceedance but after the first four qualifying storm event (QSE) results, the average is not under the NAL's for pH, TSS, Al, Fe or Zn, the facility will upgrade to include Phase 3 by September 1, 2022.

Phase 3 is comprised of an metals removing media upgrade.

Technical White Paper

Runoff Coefficient Evaluation

For Volumetric BMP Sizing

May 29, 2015

CTSW-TM-15-312.03.01

California Department of Transportation
Division of Environmental Analysis
Stormwater Program
1120 N Street, Sacramento, California 95814
http://www.dot.ca.gov/hq/env/stormwater/index.htm

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Methods used to transform rainfall depth into runoff volume for sizing volumetric stormwater BMPs are identified and explained. This includes a cursory evaluation of the current method used by Caltrans, along with an initial inventory of other methods used by various municipalities and departments of transportation (DOTs). Only the basic theory, assumptions, and suitability to the Caltrans NPDES Permit sizing requirements are provided for each method.</td></tr>
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BACKGROUND

In 2012, the State Water Resources Control Board (SWRCB) issued the California Department of Transportation (Caltrans) a statewide National Pollutant Discharge Elimination System (NPDES) stormwater permit (Order No. 2012-0011-DWQ, NPDES No. CAS 000003)(Caltrans NPDES Permit 2013). The Permit specifies sizing treatment control Best Management Practices (BMPs) for the 85th percentile, 24-hour storm event, which is much smaller than the typical storm size used for drainage design.

Certain aspects of the current Caltrans method used to transform rainfall depth to runoff volume may result in the oversizing of volumetric stormwater BMPs. This technical white paper is intended to provide a cursory evaluation of the current method used by Caltrans and to provide an initial inventory of other methods used by various municipalities and departments of transportation (DOTs) around the country. Only the basic theory, assumptions, and suitability to the Caltrans NPDES Permit sizing requirements will be provided for each method.

DRAINAGE VS. STORMWATER QUALITY DESIGN

The basic hydrology and hydraulic principles are the same whether designing a drainage system or a stormwater quality treatment BMP. However, these two types of runoff designs have very different design goals and philosophies that must be recognized in order to meet performance objectives.

The design goal for drainage systems is to protect human health and property from flooding. In order to accomplish this goal the design must have the capacity to convey runoff from a large storm, such as a 25-year recurrence interval storm. Furthermore, drainage systems are predominantly engineered to handle a specified flow rate instead of a runoff volume.

The design goal for stormwater quality treatment BMPs is to treat the many small storms that collectively transport the majority of the runoff pollutants. Treating larger and less frequent storms creates a diminishing return on installation and maintenance costs. An optimized design capacity is typically a storm that has a recurrence interval of less than 2 years. Because the runoff volume from these smaller water quality design storms is much less than the volume that is produced by a larger drainage system design storm, initial abstraction (losses from interception, depressional storage, etc. that occur before runoff begins) is a more significant factor in estimating the transformation of precipitation to runoff for small storms than it is for larger storms. In addition, the initial abstraction volume can be a large percentage of the total precipitation volume. As the amount of precipitation increases, the initial abstraction volume stays constant, which causes it to become an increasingly smaller percentage of the total precipitation volume until it reaches a point where it can be considered negligible for very large storms.

Due to differences in the targeted storm sizes between drainage design and stormwater quality treatment BMP design, the methods used to estimate runoff cannot necessarily be interchanged. Dhakal et al. (2012) recognized that volumetric-based coefficients should not be used to predict peak discharge rates, and furthermore observed that volumetric coefficients derived from data are weakly correlated to the rate-based coefficients available in the literature. This finding helps highlight the importance of recognizing that rate-based coefficients and volume-based coefficients are not the same and as such should not be used in place of each other. However, this distinction does not mean that drainage design and stormwater quality treatment BMP design requirements cannot be achieved on the

same project. Proper BMP design should include bypass and overflow elements that allow the BMP to meet the drainage design requirements.

This white paper focuses on the design storm requirements of the Caltrans NPDES Permit and therefore limits its investigation to methods available for sizing volumetric BMPs for the 85th percentile, 24-hour storms across the state which approximates a <2-year return period.

CURRENT CALTRANS METHOD

The current guidance provided by Caltrans for calculating volumetric stormwater treatment BMP sizes is provided in the *Storm Water Quality Handbooks: Project Planning and Design Guide* (PPDG; Caltrans 2012b), Section 2.4.2.2, "Treatment BMP Use and Placement Considerations." For projects with project initiation documents (PIDs) approved prior to July 1, 2013, the PPDG specifies using the 85th percentile runoff capture ratio or maximized volume approach[1] and refers the designer to the Basin Sizer design tool (Caltrans 2007) to perform the calculations. Projects with PIDs approved after this date will use the 85th percentile 24-hour storm event in the new NPDES order.

In Basin Sizer version 1.45 and earlier, a runoff depth equivalent is estimated by multiplying the rainfall depth for the selected location by a user-provided composite runoff coefficient. The runoff depth equivalent can then be multiplied by the drainage area to get the runoff volume. However, both the PPDG and Basin Sizer guidance are unclear on what input values to use for the composite runoff coefficient for the drainage area. The *Highway Design Manual* (HDM; Caltrans 2014) is also silent on how to estimate runoff volumes for sizing stormwater BMPs, and provides no guidance on selecting an appropriate runoff coefficient. Without explicit guidance for volumetric coefficients, Caltrans designers use the HDM Figure 819.2A, "Runoff Coefficients for Undeveloped Areas," and Table 819.2B, "Runoff Coefficients for Developed Areas."

In 2013, the Caltrans Infiltration Tools version 3.01 (Caltrans 2013a; Caltrans 2013b) was released. The Infiltration Tools use Basin Sizer to get a design storm depth (not a runoff depth). If using Basin Sizer version 1.45 and earlier a composite runoff coefficient of 1.0 must be used; in version 1.46 (the most recent) the runoff coefficient input has been removed so that only a rainfall depth is provided. Regardless of which version of Basin Sizer is used to get the rainfall depth, the transformation of rainfall to runoff is calculated within the Infiltration Tools by multiplying the rainfall depth by the drainage area and a runoff coefficient. Two runoff coefficients are used: the first coefficient is 0.9, for impervious areas; the second is based on user inputs for the pervious areas taken directly from the HDM, Figure 819.2B.

Both the original Basin Sizer method and the newer Infiltration Tools/Basin Sizer method use runoff coefficients from the HDM. These coefficients are intended to be used with the rational method for estimating peak design discharge (i.e., flow rate). Often referred to as *C* values, they represent the ratio between rainfall intensity and peak flow rate. This allows them to act as the transformation function within the rational method to estimate flow rate (i.e., volume per time) from precipitation intensity (i.e., depth per time). Furthermore, the rational method and its coefficients are intended for use in estimating peak runoff from large storm events (typically the 10-year recurrence interval and larger).

[1] The PPDG sizing method will be revised to match the 2013 Caltrans NPDES Permit requirements of the 85th percentile, 24-hour storm event (Order No 2012-0011-DWQ).

This is in contrast to the design objective for sizing a volumetric BMP, which needs to estimate runoff volume as a function of precipitation depth for much smaller and more frequent storm events.

While use of the current HDM runoff coefficient values in the sizing of volumetric BMPs is not necessarily appropriate, the resulting design sizes are permit-compliant since these rate-based coefficients tend to oversize BMPs relative to BMPs sized with a more appropriate coefficient from one of the techniques described later in this technical white paper.

SMALL STORM HYDROLOGY METHOD (SSHM)

The Small Storm Hydrology Method (SSHM) is currently the most widely used non-computerized model for the calculation of stormwater volume runoff (see Appendix A). There are several different forms of the equation used by various municipalities across the nation, but, ultimately, they can all be described by Equation 1. It is based on the simple mass balance principle that a proportion of the rainfall on a drainage area translates into runoff.

$$\forall_R = R_v P A \qquad \textbf{Equation 1}$$

Where: $\forall_R$ = *Runoff Volume [L^3]*
R_v = *Volumetric Runoff Coefficient [unitless]*
P = *Precipitation Depth [L]*
A = *Drainage Area [L^2]*

In the SSHM, the Volumetric Runoff Coefficient (R_v) is defined as the ratio of runoff volume to precipitation volume (Equation 2). It can either be assigned based on drainage area characteristics or it can be calculated as an area-weighted composite.

$$R_v = \frac{\forall_R}{\forall_P} \qquad \textbf{Equation 2}$$

Where: $\forall_P$ = *Precipitation Volume [L^3] =* PA

Three approaches have emerged as the preferred techniques of obtaining R_v values: 1) linear regression equations based on the percent impervious, 2) polynomial equations based on percent impervious, and 3) look-up tables based on land use/cover and precipitation depth. All of these approaches are empirical and the results are sensitive to the precipitation distribution and land uses in the locations where the data were collected.

Linear Regression Equations

Using data from the National Urban Runoff Program (NURP), Driscoll (1983) calculated the mean R_v at over 50 monitored sites. He was able to show that the majority of the variation within the mean R_v values for each site was attributed to the amount of urbanization or imperviousness within the drainage area. While working for the Metropolitan Washington Council of Governments, Schueler used a subset of Driscoll's data and adding a few more sites to compile a table of 44 sites with percent impervious, mean R_v, and median R_v values (WMWRPB 1987). Based on this composite data set, Schueler used simple linear regression to derive Equation 3, which predicts a mean R_v based on the percent impervious.

$$R_v = 0.05 + 0.009(I) \qquad R^2 = 0.71$$ **Equation 3**

Where: R_v = *Volumetric Runoff Coefficient [unitless]*
I = *Percent Impervious of Drainage Area (0-100)*

The majority of the municipal design manuals reviewed for this white paper (Appendix A) use Equation 3. While not published in the literature, if outliers are removed from the data set Equation 4 is obtained. About 20% of the municipal design manuals reviewed used this form of the equation.

$$R_v = 0.015 + 0.0092(I) \qquad R^2 = 0.86$$ **Equation 4**

Reese (2006) proposed using the median R_v instead of the mean R_v (Equation 5) to develop an alternate relationship. This alternative, while not used prolifically in professional practice, has validity because it is more robust for data sets containing outliers. Outliers caused by measurement errors are inevitable when measuring small runoff events, so using median values reduces the impact of erroneous measurements. As a result, Equation 5 provides a practical and intuitive result that shows that highly pervious catchments do not produce runoff from the smallest storms considered.

$$R_v = 0.0091(I) - 0.0204 \qquad R^2 = 0.85$$ **Equation 5**

Figure 1 displays a graph of the Schueler data and the three linear regression equations derived from the data. The right side of the plot area (white side) identifies the range of percent impervious within which Caltrans typically has to design and size stormwater BMPs. It is important to recognize that only about 20% of the data used to derive these relationships are within this range. It is also important to recognize that the fundamental assumption about all three equations is that R_v only changes with percent impervious and is not affected by any other factors such as storm characteristics (e.g., intensity, depth, duration). The one shortcoming of Equation 5 then is that due to the constraints of fitting a straight line through the data, sites with very low percent imperviousness result in a negative R_v which is not physically possible, so results should be limited to positive values. However, this limitation would not likely impact the highway environment because the percent impervious typically remains well above 50% where treatment BMPs are required.

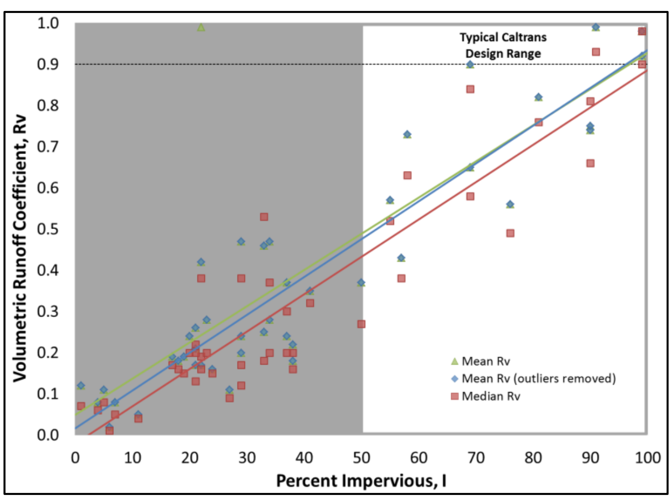

Figure 1 – Comparison of the linear regression equations developed from the Schueler (1987) data.

Polynomial Equations

Recognizing that there may be a better model for the NURP data, Urbonas (1999) proposed a third order polynomial equation to estimate R_v (Equation 6; Figure 2). This equation is presented in Urban Runoff Quality Management (WEF and ASCE 1998) and included in the California Stormwater BMP Handbook: New Development and Redevelopment (CASQA 2003). Also, according to Dhakal et al. (2012), this equation was used in the 2010 Drainage Criteria Manual for the Denver Urban Drainage and Flood Control District.[2] Equation 6 was derived using median R_v values from 60 NURP sites.

Equation 6

$$R_v = 0.858\left(\frac{I}{100}\right)^3 - 0.78\left(\frac{I}{100}\right)^2 + 0.774\left(\frac{I}{100}\right) + 0.04 \qquad R^2 = 0.72$$

Note: *Variables used in the original published equation have been adjusted for internal consistency within this technical white paper.*

Equation 6 is more complicated than Equations 3-5 and provides some valuable insight. As shown in Figure 2, Equation 6 follows a similar trend for the lower R_v values estimated by Equation 5 for areas with a higher percentage of impervious surfaces. It also rectifies the negative R_v values of Equation 5 for areas with little to no impervious surfaces.

Dhakal et al. (2012) added 45 sites from Texas to the 60 NURP sites to derive Equation 7.

Equation 7

$$R_v = 1.843\left(\frac{I}{100}\right)^3 - 2.275\left(\frac{I}{100}\right)^2 + 1.289\left(\frac{I}{100}\right) + 0.036 \qquad R^2 = 0.57$$

Note: *Variables used in the original published equation have been adjusted for internal consistency within this white paper.*

Perhaps the most important point that the third order polynomial equations illustrate is the degree to which R_v may not be a linear function. The slope of the lines in Figure 2 represents the rate of change in R_v with respect to percent impervious. The linear regression equations have a constant slope, therefore R_v is directly proportional to percent impervious. However, the Urbonas and Dhakal et al. approaches have more complex relationships between R_v and percent impervious. The slope of the line is greatest in both of these equations for high percent impervious (>75%). This is the range where the infiltration in the pervious areas is overwhelmed by the excess runoff from the impervious surfaces. The Dhakal et al. (2012) equation has more curvature because of how the additional Texas data points are clustered. This factor introduces a bias into Equation 7, making its applicability questionable for areas outside of where the additional data were collected.

[2] The equation appears to have been removed in the 2013 edition of the manual.

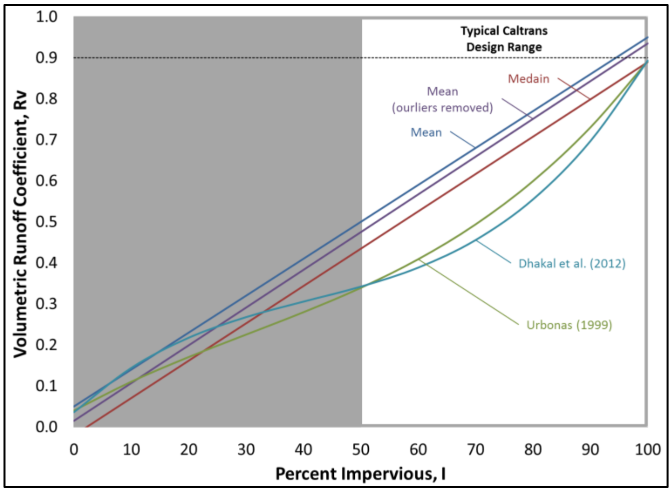

Figure 2 - Comparison of the five volumetric runoff coefficient estimation equations.

Categorical Look-Up Tables

All of the R_v look-up tables that were found in the literature review (see Appendix A) referenced Pitt's PhD dissertation (1987), so there do not appear to be any variants to discuss. One of the more thorough commercially available publications of the tables is in *Stormwater Effects Handbook: A Toolbox for Watershed Managers, Scientists, and Engineers* (Burton and Pitt 2002). The distinct improvement that Pitt's tabular approach has over the percent impervious equations is that the R_v values vary with both percent impervious and total precipitation depth. The sensitivity of this approach to precipitation depth is intuitive when thinking about the physical processes involved in the relationship between precipitation and runoff. Initial abstraction accounts for a finite volume loss. With small storms the initial abstraction volume is a more significant percentage of the total precipitation than for larger storms. Infiltration rates also tend to vary during small storms because the soil has not yet reached its saturated hydraulic conductivity.

The drawback of this approach is that the tables use a categorical drainage area type. There are only seven surface categories and three land use categories, requiring a subjective decision by the designer about which category to use when selecting the R_v. It is also important to recognize that there was no record in the literature of these findings having ever been duplicated or validated, which makes it difficult to determine if there are problems with the underlying data and what the variability of the R_v values may be. In addition, the R_v values are presented in several tables, making it confusing as to which table should be used, although this issue can be easily overcome by combining tables or developing a simple algorithm for use in one of the Caltrans design tools.

Figure 3 is a graph of Pitt's data. The central white section of the plot area identifies the range of 85th percentile, 24-hour precipitation depths from Basin Sizer version 1.47 that occur within California (0.23 inches at Cow Creek and 2.28 inches at Honeydew 1 SW). Figure 3 clearly shows how the R_v rapidly increases for about the first 0.5 inch due to filling of the initial abstraction volume. It then continues to increase with precipitation at a constant, but much slower rate, which reflects relatively smaller infiltration losses after runoff develops. The difference between "Large paved areas and freeways" and "Roads and other small impervious areas" is unclear, but the assumption is that freeways are constructed with a denser, smoother, and less degraded pavement than the typical urban street (Pitt 1999). This is an important assumption that should be validated before using this approach.

Furthermore, the fact that freeways have R_v values greater than pitched roofs is questionable and indicates that results were generated from a limited data set.

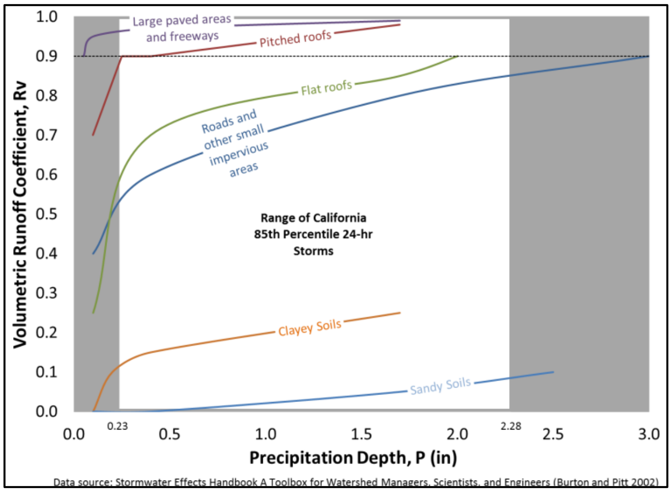

Figure 3 – Pitt's volumetric runoff coefficients for different rainfall depths (data from Burton and Pitt 2002).

CURVE NUMBER (CN) METHOD

The Soil Conservation Service (SCS), now known as the Natural Resources Conservation Service (NRCS), originally developed their hydrology techniques based on unit hydrograph theory and curve numbers in the 1940s and 1950s (USDA-NRCS 2004). Hydrologic calculations were originally done by hand, but in the 1960s the process was coded into a computer program that was documented in Technical Release 20 (TR-20), *Computer Program for Project Formulation Hydrology* (USDA-SCS 1992). Utilizing output from TR-20, the SCS was then able to develop further simplified techniques for estimating runoff and peak discharges in Technical Release 55 (TR-55), *Urban Hydrology for Small Watersheds* (USDA-NRCS 1986). Two separate hydrologic methods are utilized within TR-20 and TR-55. The first is the curve number (CN) method that calculates a storm event's direct runoff depth based on a precipitation depth and land use/cover. The second method is the dimensionless unit hydrographs that convert the direct runoff depth to a hydrograph with a peak flow rate (ASCE/EWRI 2009).

Today, TR-55 provides the most common form of the CN method used with stormwater calculations. Its theory is based on the use of a *CN* to estimate the potential maximum retention after runoff begins (Equation 8) and the initial abstraction (Equation 9).

$$S = \frac{1000}{CN} - 10$$ **Equation 8**

Where: *S = Potential Maximum Retention After Runoff Begins (in)*
CN = Curve Number (unitless)

$$I_a = 0.2S$$ **Equation 9**

Where: I_a *= Initial Abstraction (in)*

The theoretical basis for TR-55 then ties *S* and I_a together using Equation 10, which is a hyperbolic equation to estimate the runoff depth.

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$ **Equation 10**

Where: *Q = Runoff Depth (in)*
P = Precipitation Depth (in)

One of the benefits of using the TR-55 CN method to comply with the Caltrans NPDES Permit requirements is that the method is based completely on 24-hour storm events, which conveniently matches with the Permit's 85th percentile, 24-hour storm event sizing requirement. However, the NRCS (2009) makes a point of identifying limitations of the TR-55 method, including accuracy issues with less than 0.5 inch of runoff. Furthermore, Claytor and Schueler (1996) state that the CN method underestimates the runoff volume for small storms less than 2 inches, and provide explanations in their Table 2.10.[3] This is the reason why most agencies do not use the TR-55 CN method to estimate runoff volume. The NRCS also points out that the 0.2*S* relationship is based on data from agricultural watersheds, which has the potential to generate erroneous I_a estimates in urban watersheds. This can be easily observed by assuming a *CN* of 98 for impervious areas, which calculates an I_a of 0.04 inch (1 mm) using Equation 9. Observation of any paved surface during a light rain event would suggest that this I_a is small since the adhesion and cohesion of the water on the roadway alone would likely account for at least this much of a loss even before depressional storage or initial infiltration are considered.

Figure 4 provides curves of R_v values calculated using the TR-55 CN method as a function of precipitation depth for different percent imperviousness. The percent impervious assumes a *CN* of 98 for impervious surfaces and 70 for pervious surfaces. While the exact values may not be correct, the outcome of this analysis is very insightful. All of the curves have an R_v of zero when the precipitation equals I_a. For precipitation greater than I_a the curves are smooth, well behaved, and probably accurate. For precipitation less than I_a the curves display asymptotic behavior approaching an R_v of infinity at a precipitation of zero. This is the likely reason why NRCS suggests a minimum runoff depth of 0.5 inch. However, Figure 4 illustrates that this anomaly lessens with increased *CN* such that a site with 100 percent impervious area is virtually unaffected. While further investigation is needed, it appears that this limitation may not be a significant factor for the types of percent impervious areas that Caltrans typically designs.

[3] Claytor and Schueler's conclusions are based on an unpublished manuscript presented by Pitt at a conference in 1994. A copy of this manuscript could not be located to include its contents in this technical white paper, yet many of the municipal design manuals listed in Appendix A reference it when explaining why the CN method should not be used to estimate runoff volumes for small storms. See Pitt, Robert E. 1994. Small Storm Hydrology. Presented at Design of Stormwater Quality Management Practices, Madison, WI, May 17-19.

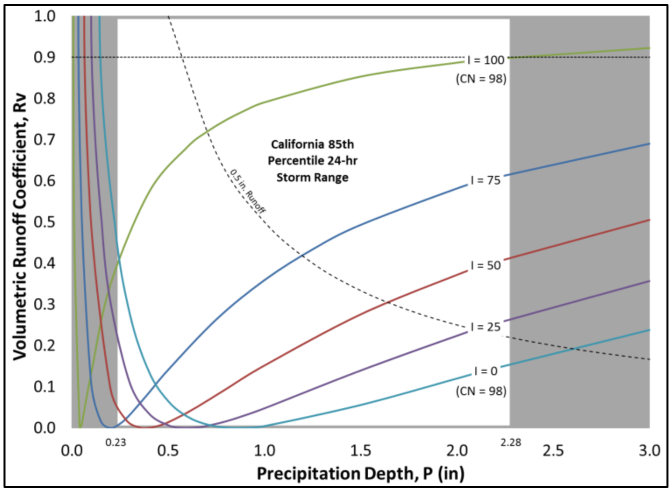

Figure 4 – Volumetric runoff coefficients for varying precipitation depths and percent impervious (CN 70 to 98).

Using the same assumptions for percent impervious (*CN* range from 70 to 98), Figure 5 shows R_v as a function of percent impervious for different precipitation depths. As the depth increases, the line straightens out, similar to the three linear regression equations. Conversely, smaller precipitation depths have more curvature, similar to the polynomial equations, because they are more affected by the initial abstraction. As discussed earlier, the exact values of the lines may not be correct, but this graph provides theoretical support for non-linear solutions, such as the third order polynomial equations, for smaller stormwater quality design storms, and the linear regression equations for larger storms.

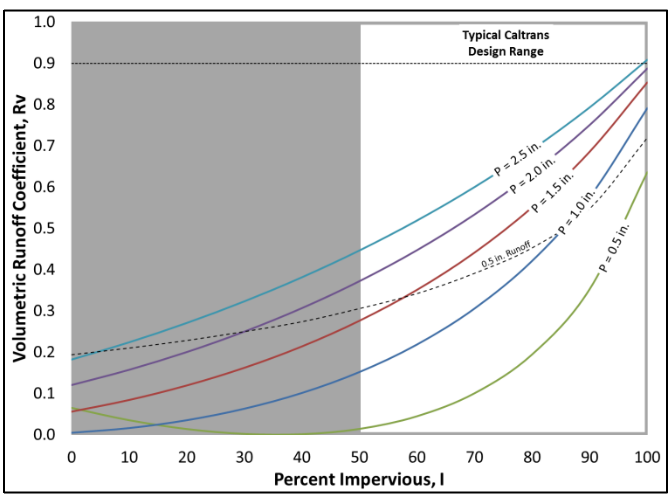

Figure 5 - Volumetric runoff coefficients for varying percent impervious (CN 70 to 98) and precipitation depths.

While the TR-55 CN methodology may not be appropriate for use with all stormwater quality design storms, the underlying CN methodology is still a valid model. Fortunately, the computer version (WinTR-55[4]) eliminates these issues because it uses an algorithm based on TR-20 (USDA-NRCS 2009). Further

[4] Available at http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/?cid=stelprdb1042901

investigation into the applicability of WinTR-55 for sizing stormwater quality treatment BMPs in the highway environment would be needed before this method could be adopted.

COMPUTER MODELS

The two most common computer models used to model stormwater runoff (i.e., runoff volume, infiltration, etc.) are the US EPA Storm Water Management Model (SWMM)[5] and the joint US EPA and USGS Hydrological Simulation Program FORTRAN (HSPF).[6] The reason for the popularity of these models is that they can both perform continuous simulation. Due to the significantly more advanced and complex nature of these types of models, continuous simulation computer models are not within the scope of this white paper. However, they are mentioned here because of the potential to use them for either verification or calibration of the other models discussed.

For single event design storm analysis, the USACE HEC-HMS and the USGS WinTR-55 are the most common. WinTR-55 is used more often for stormwater BMP sizing, likely because of its ties to the original TR-55 method.

RECOMMENDATIONS

The rate-based runoff coefficients from the HDM were not developed for small storm volumetric BMP sizing. In order to calculate the most accurate volume estimate, both percent impervious and precipitation depth should be utilized. To help illustrate this point, Appendix B contains a table that compares the R_v values between the different techniques presented. The TR-55 column shows how the R_v values decrease not only with percent impervious, like the other techniques, but also with the precipitation depth. The Appendix B table spans the full range of California's 85th percentile, 24-hour rainfall depths.

Currently, there is no simple method that is widely accepted by the stormwater industry that accounts for both percent impervious and precipitation depth when dealing with small storms. The CN method is not appropriate for smaller storms, and other methods reviewed for R_v estimation do not account for differences with precipitation depth. As a way to work around this shortcoming in knowledge, the recommendations are divided into short-term and long-term recommendations.

The short-term recommendations can be implemented immediately and are based on the current state of knowledge. They identify a way to use existing methods in such a way that they can be appropriately utilized by Caltans in the highway environment. If Caltrans decides that a more accurate method for estimating runoff volumes is needed then the long-term recommendations have been provided. These recommendations require further investigation and analysis to be implemented. However, they have the potential to provide a more accurate solution that is calibrated to the Caltrans highway environment.

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[5] Available at http://www.epa.gov/nrmrl/wswrd/wq/models/swmm/
[6] Available at http://water.usgs.gov/software/HSPF/

To illustrate the subtle differences between the various methods and techniques discussed in this white paper, and to see how the following recommendations could improve the accuracy of the volume estimates, an example problem is provided in Appendix C.

Short-Term Recommendations

As explained previously, the runoff coefficients currently in the HDM tend to overestimate runoff volumes because they are meant for use with the rational method to estimate peak discharges. To make volumetric BMP designs more accurate, it is recommended that guidance for sizing volumetric stormwater BMPs be added to the rate-based guidance in either the PPDG or HDM. This will provide a single defined reference for Caltrans designers to use. The guidance may be updated appropriately as additional information and analyses are available to better refine the methods and techniques used.

For volumetric BMP sizing, using the SSHM is initially recommended because of its adoption by most other municipalities throughout the country. However, instead of identifying a single technique to obtain the R_v values, provide designers with a Caltrans-specific table of values (Table 1). Values provided in the table can draw from different sources and techniques as they are deemed appropriate for the highway environment. Initially the table can use the Urbonas (1999) equation for areas with 50-100% imperviousness because it is more sophisticated than the linear regression equations by addressing the non-linear nature of the R_v value. It also has been included in both national (WEF and ASCE 1998) and state-wide guidance (CASQA 2003) publications which are current standards for the stormwater industry.[7,8] Average R_v values for clayey and sandy soils from Burton and Pitt (2002) should also be included in the table. In order to provide a transition from the Urbonas derived values which group all types of pervous surfaces to the soil type specific Burton and Pitt derived values, an applicable lower bound of 50% impervious is recommended. This is because the runoff from drainages with less than 50% impervious area is controlled by the type of soil. Setting the table up this way gives the designer the flexability in choosing a R_v value. The decision in selecting an appropriate R_v value should be based on how water flows between impervious and pervious areas. If the drainage patterns are such that water flows from impervious to pervious areas then the analysis can be done using the percent impervious R_v values from Table 1. However, if water flows from pervious to impervious areas, or the percent impervious is less than 50%, or the runoff from pervious and impervious areas are engineered not to comingle then a separate analysis of the pervious and impervious areas may be more appropriate.

Providing the R_v values in a table gives Caltrans the flexibility to update selection guidance as the state of knowledge is advanced, without having to completely rewrite sections of the design guidance (Table 1). As more data is available the tables can be updated in the future to adapt to Caltrans needs for complying with the NPDES permit. Eventually, the table can even be modified to show R_v values for different combinations of percent impervious and precipitation depths.

[7] The Dhakal et al. (2012) equation appears to be biased by the additional data included in their analysis although it does support the non-linear nature of the relationship between percent impervious and R_v.

[8] The linear regression equations are part of the Caltrans Hydrologic Utility v. 3.0 (Caltrans 2012a) quality control process in determining if monitored runoff data contain errors; however their simplicity causes them to be more conservative and less accurate.

Table 1: Recommended initial table of volumetric runoff coefficients (R_v)

Description	Volumetric Runoff Coefficient (R_v)	Source
100% Impervious	0.89	Urbonas 1999
90% Impervious	0.73	Urbonas 1999
80% Impervious	0.60	Urbonas 1999
70% Impervious	0.49	Urbonas 1999
60% Impervious	0.41	Urbonas 1999
50% Impervious	0.34	Urbonas 1999
Clayey Soils[1]	0.22	Burton and Pitt 2002
Sandy Soils[1]	0.03	Burton and Pitt 2002

[1] Value for an average California 85th percentile, 24-hour storm event depth of 1.26 inches.

Long-Term Recommendations

The following long-term recommendations are provided in order of easiest to most extensive. The estimated duration of time needed to implement each of these recommendations is included.

- Data mine the Caltrans Stormwater Data Archive (SDA) to develop a California highway-specific R_v data set. Use the data to develop an equation that estimates R_v as a function of percent impervious and precipitation depth. (Estimated duration: 4-8 months after the SDA flow data review is completed)

- Re-calculate the R_v linear regression and polynomial equations using only the NURP sites with percent impervious > 50%, and add a confidence interval to each prediction equation. Results can then be compared against studies in the Caltrans SDA. (Estimated duration: 1-2 months)

- Investigate the validity of using the WinTR-55 computer program to access the TR-20 method to calculate the runoff volumes. Using a computer program will be especially helpful for drainage areas with both connected and disconnected impervious areas. Please note that in a preliminary investigation, WinTR-55 (TR-20) estimated a substantially lower R_v than the original TR-55 method. This result will need to be explained. (Estimated duration: 6-8 months)

- Use the TR-20 method to develop a new relationship between I_a and S for pavement-dominated drainage areas and small storms, as recommended by the NRCS. This method can be used in place of the TR-55 equations. (Estimated duration: 6-12 months after the investigation into the validity of using the WinTR-55 computer program has been completed)

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APPENDIX A

List of some of the municipality design manuals using the Small Storm Hydrology Method.

Design Manual	Method/Technique	Table/ Curve
Fort Wayne, Indiana, Stormwater Design and Specification Manual (2009)	SSHM with R_v = 0.05+0.009(I)	N
Lawrence Village, Georgia, Stormwater Design Manual	SSHM with R_v = 0.05+0.009(I)	N
New York State Stormwater Management Design Manual (2010)*	SSHM with R_v = 0.05+0.009(I)	Y
Indianapolis, Indiana, Stormwater Specifications Manual (2011)	SSHM with R_v = 0.05+0.009(I)	N
Boone County, Michigan, Stormwater Design Manual	SSHM with R_v = 0.05+0.009(I)	N
Dallastown, Pennsylvania, Stormwater Management (2005)	SSHM with R_v = 0.05+0.009(I)	N
Andover, Massachusetts, Stormwater Management and Erosion Control Regulations (2009)	SSHM with R_v = 0.05+0.009(I)	N
Department of Transportation, Hawaii Post Construction BMP Training (2012)	SSHM with R_v = 0.05+0.009(I)	N
Minnesota Pollution Control Agency, The Simple Method for Estimating Phosphorus Export	SSHM with R_v = 0.05+0.009(I)	N
Georgia Coastal Stormwater Supplement (2009)	SSHM with R_v = 0.05+0.009(I)	N
Salisbury, Maryland, Wastewater Treatment Plant PER	SSHM with R_v = 0.05+0.009(I)	N
Maryland Stormwater Design Manual (2000)*	SSHM with R_v = 0.05+0.009(I)	N
Alaska Storm Water Guide (2011)*	SSHM with R_v = 0.05+0.009(I)	N
Newton, Kansas, Post Construction Best Management Practices Manual	SSHM with R_v = 0.05+0.009(I)	Y
Virginia Stormwater Management Handbook (2013)*	SSHM with R_v = 0.05+0.009(I)	N
Madisonville, Kentucky, Storm Water Management	SSHM with R_v = 0.05+0.009(I)	N
Columbia, Missouri, Stormwater Management and Water Quality Manual (2013)	SSHM with R_v = 0.05+0.009(I)	Y
North Carolina Division of Water Quality, Stormwater Best Management Practices Manual (2007)*	SSHM with R_v = 0.05+0.009(I)	N
New Hampshire Stormwater Manual: Volume 2 (2008)*	SSHM with R_v = 0.05+0.009(I)	N

Design Manual	Method/Technique	Table/ Curve
City of Mexico Stormwater Manual	SSHM with R_v = 0.05+0.009(I)	N
Knox County, Tennessee, Stormwater Management Manual	SSHM with R_v = 0.015 + 0.0092(I)	N
Franklin, Tennessee, Water Quality Policy and Procedures	SSHM with R_v = 0.015 + 0.0092(I)	N
Elizabethton, Tennessee, Water Quality BMP Manual (2008)	SSHM with R_v = 0.015 + 0.0092(I)	Y
Rutherford, Tennessee, Stormwater Best Management Practices (2006)	SSHM with R_v = 0.015 + 0.0092(I)	N
Washington State Dept. of Transportation, Highway Runoff Manual (2011)	Continuous Simulation	N
Pennsylvania Department of Environmental Protection, Pennsylvania Stormwater Best Management Practices Manual (2006)	Look-Up Table	Y
Southeast Michigan Council of Governments, Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers (2008)*	Look-Up Table	Y

*Statewide guidance utilized by DOTs

APPENDIX B

Comparison of volumetric runoff coefficients (R_v) obtained using different methods.

Range of 85% 24-hr CA PCP (in)	% Imp	Current Caltrans Practice (HDM Table 819.2B)[1]	Small Storm Hydrology Method: Linear Regression Equations: Eq. 3 Schueler (1987) -Mean-	Eq. 4 Schueler (1987) w/o Outliers -Mean-	Eq. 5 Reese (2006) -Median-	Polynomial Equations: Eq. 6 Urbonas (1999)	Eq. 7 Dhakal et al. (2012)	Categorical Look-Up Tables: Categorical Pitt (1987)[2]	TR-55: CN NRCS[3]
2.28 *(Honeydew[4])*	100%	0.95	0.95	0.94	0.89	0.89	0.89	0.86	0.90
	75%	0.79	0.73	0.71	0.66	0.54	0.50	0.72	0.62
	50%	0.63	0.50	0.48	0.43	0.34	0.34	0.59	0.41
1.00	100%	0.95	0.95	0.94	0.89	0.89	0.89	0.71	0.79
	75%	0.79	0.73	0.71	0.66	0.54	0.50	0.58	0.38
	50%	0.63	0.50	0.48	0.43	0.34	0.34	0.46	0.18
0.62 *(Sac)*	100%	0.95	0.95	0.94	0.89	0.89	0.89	0.65	0.70
	75%	0.79	0.73	0.71	0.66	0.54	0.50	0.53	0.21
	50%	0.63	0.50	0.48	0.43	0.34	0.34	0.42	0.05
0.23 *(Cow Crk[5])*	100%	0.95	0.95	0.94	0.89	0.89	0.89	0.54	0.40
	75%	0.79	0.73	0.71	0.66	0.54	0.50	0.44	0.00
	50%	0.63	0.50	0.48	0.43	0.34	0.34	0.33	0.00

[1] Assumes coefficients of 0.95 for impervious surfaces and 0.30 for pervious surfaces

[2] Assumes coefficients from *Roads and other small impervious areas* for impervious surfaces and *Clayey soils* for pervious surfaces as shown in Figure 3

[3] Assumes CN of 98 for impervious surfaces and 70 for pervious surfaces

[4] Largest 85% 24-hour precipitation station from Basin Sizer

[5] Smallest 85% 24-hour precipitation station from Basin Sizer

APPENDIX C

Example Problem

Project Description

The project is a new 3-lane section of highway located in Sacramento County. One of the drainages in the project is a 0.3-mile (1633 feet) stretch with 2 new lanes (12 feet each), a 3-foot impermeable shoulder with a curb, and a cut slope that is approximately 27 feet wide. A slope intercept drain is installed at the top of the cut slope to prevent run-on. Two of the lanes, the shoulder, and the cut slope drain to a newly proposed BMP that needs to be sized volumetrically. The surrounding soil is a Type C soil with native grasses. The 85th percentile, 24-hour rainfall depth for Sacramento is 0.62 inch. Figure C1 is a schematic of this example problem.

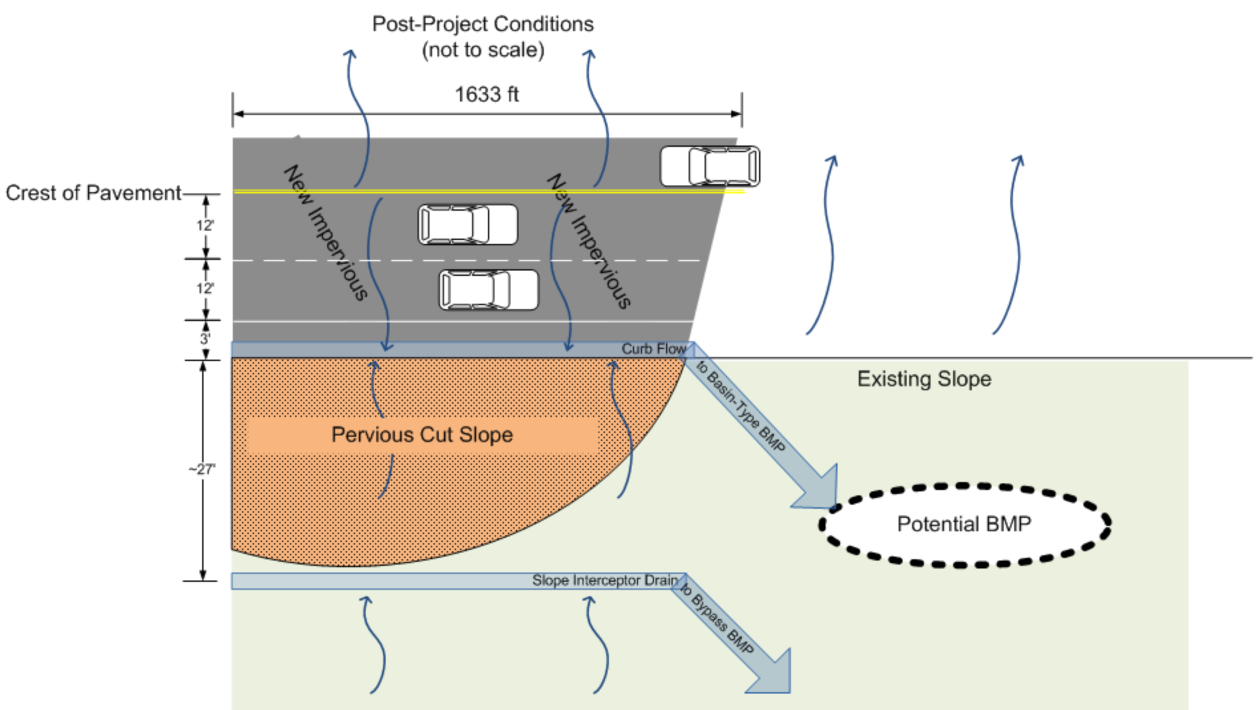


Figure C1 – Schematic of Example Problem

Solution

1. Calculate areas

The contributing drainage area (CDA) to the BMP consists of the two lanes, impermeable shoulder, and the area below the slope intercept drain.

$$CDA = (12\,ft + 12\,ft + 3\,ft + 27\,ft) \times \left(1633\,ft \times \frac{1\,ac}{43560\,ft^2}\right) = 2\,ac$$

The net new impervious (NNI) area consists of only the two lanes and impermeable shoulder.

$$NNI\ Area = (12\,ft + 12\,ft + 3\,ft) \times \left(1633\,ft \times \frac{1\,ac}{43560\,ft^2}\right) = 1\,ac$$

The percent impervious for the CDA can now be calculated.

$$\%\,Imp = \frac{NNI\ Area}{CDA} \times 100 = \frac{1\,ac}{2\,ac} \times 100 = 50\%$$

2. Volumetric Runoff Coefficients

The volumetric runoff coefficient (R_v) should be calculated for both the water quality volume (WQV) coming off of the NNI area (100% impervious) and the target capture volume coming off of the CDA (50% impervious). For comparison purposes, calculations from four of the most viable techniques are provided.

Current Caltrans Practice:

From the Caltrans Highway Design Manual (HDM), Table 819.2B, a conservative runoff coefficient for streets (impervious surface) is 0.95, and for unimproved areas (pervious surface) is 0.30. The composite runoff coefficient can then be calculated using an area-weighted approach:

$$C_{100\%} = 0.95$$

$$C = \frac{C_1 A_1 + C_2 A_2}{A_1 + A_2}$$

$$C_{50\%} = \frac{(0.95 \times 1\,ac) + (0.30 \times 1\,ac)}{1\,ac + 1\,ac} = 0.63$$

Reese (2006):

The Reese (2006) equation is a linear regression equation that estimates median R_v values based on the drainage area's percent impervious.

$$R_v = 0.0091(I) - 0.0204$$

$$R_{v\,100\%} = 0.0091(100) - 0.0204 = 0.89$$

$$R_{v\,50\%} = 0.0091(50) - 0.0204 = 0.43$$

Urbonas (1999):

The Urbonas (1999) equation is a third order polynomial equation that estimates median R_v values based on the drainage area's percent impervious.

$$R_v = 0.858\left(\frac{I}{100}\right)^3 - 0.78\left(\frac{I}{100}\right)^2 + 0.774\left(\frac{I}{100}\right) + 0.04$$

$$R_{v\,100\%} = 0.858\left(\frac{100}{100}\right)^3 - 0.78\left(\frac{100}{100}\right)^2 + 0.774\left(\frac{100}{100}\right) + 0.04 = 0.89$$

$$R_{v\,50\%} = 0.858\left(\frac{50}{100}\right)^3 - 0.78\left(\frac{50}{100}\right)^2 + 0.774\left(\frac{50}{100}\right) + 0.04 = 0.34$$

TR-55 CN Method:

The TR-55 CN method uses curve numbers as the coefficient instead of volumetric runoff coefficients. From the Urban Hydrology for Small Watersheds (NRCS 1986), Table 2-2, a curve number for streets (impervious surface) is 98, and for a grassland/meadow area (pervious surface) is 70. The composite curve number can then be calculated on TR-55, Worksheet 2 using an area weighted approach:

$$CN = \frac{CN_1A_1 + CN_2A_2}{A_1 + A_2}$$

$$CN_{100\%} = 98 \;\rightarrow\; Q_{0.62\,in} = 0.43\,in$$

$$R_{v\,100\%} = \frac{Q}{P} = \frac{0.43\,in}{0.62\,in} = 0.69$$

$$CN_{50\%} = \frac{(98 \times 1\,ac) + (70 \times 1\,ac)}{1\,ac + 1\,ac} = 84 \;\rightarrow Q_{0.62\,in} = 0.027\,in$$

$$R_{v\,50\%} = \frac{Q}{P} = \frac{0.027\,in}{0.62\,in} = 0.043$$

3. Target Capture Volume

The target capture volume can now be calculated for the runoff coming off of the CDA.

Current Caltrans Practice:

$$\forall = 0.63 \times 0.62in\left(\frac{1ft}{12in}\right) \times 2ac\left(\frac{43560\,ft^2}{1ac}\right) = 2836ft^3$$

Reese (2006):

$$\forall_R = 0.62in\left(\frac{1ft}{12in}\right) \times 0.43 \times 2ac\left(\frac{43560\,ft^2}{1ac}\right) = 1936ft^3$$

Urbonas (1999):

$$\forall_R = 0.62in\left(\frac{1ft}{12in}\right) \times 0.34 \times 2ac\left(\frac{43560\,ft^2}{1ac}\right) = 1530ft^3$$

TR-55 CN Method:

$$S = \frac{1000}{CN} - 10 \qquad Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

$$S = \frac{1000}{84} - 10 = 1.90in \qquad Q = \frac{\left(0.62in - 0.2(1.90in)\right)^2}{\left(0.62in + 0.8(1.90in)\right)} = 0.027in$$

$$\forall_R = QA$$

$$\forall_R = 0.027in\left(\frac{1ft}{12in}\right) \times 2ac\left(\frac{43560\,ft^2}{1ac}\right) = 196ft^3$$

4. Water Quality Volume

The water quality volume (WQV) can now be calculated for the runoff coming from the NNI area.

Current Caltrans Practice:

$$\forall = CPA$$

$$\forall = 0.95 \times 0.62in\left(\frac{1ft}{12in}\right) \times 1ac\left(\frac{43560\,ft^2}{1ac}\right) = 2138ft^3$$

Small Storm Hydrology:

$$\forall_R = PR_vA$$

Using Reese (2006):

$$\forall_R = 0.62in\left(\frac{1ft}{12in}\right) \times 0.89 \times 1ac\left(\frac{43560\,ft^2}{1ac}\right) = 2003ft^3$$

Using Urbonas (1999):

$$\forall_R = 0.62in\left(\frac{1ft}{12in}\right) \times 0.89 \times 1ac\left(\frac{43560\,ft^2}{1ac}\right) = 2003ft^3$$

TR-55 CN Method:

$$S = \frac{1000}{CN} - 10 \qquad\qquad Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

$$S = \frac{1000}{98} - 10 = 0.20in \qquad\qquad Q = \frac{\big(0.62in - 0.2(0.20in)\big)^2}{\big(0.62in + 0.8(0.20in)\big)} = 0.431in$$

$$\forall_R = QA$$

$$\forall_R = 0.431in\left(\frac{1ft}{12in}\right) \times 1ac\left(\frac{43560\, ft^2}{1ac}\right) = 1565ft^3$$

5. Summary

Tables 1 and 2 provide a comparison of the runoff coefficients and resulting WQV and Target Capture Volumes using the four different methods.

Table 1 – Comparison of Runoff Coefficients

		Eq. 5	Eq. 6	TR-55	
				NRCS	
Surface Type	Current Caltrans Practice (HDM Table 819.2B)	Reese (2006) -Median-	Urbonas (1999)	CN	R_v equivalent*
Impervious (100%)	0.95	0.89	0.89	98	0.70
Composite (50%)	0.63	0.43	0.34	84	0.05

*For the condition of 0.62 inches in 24-hours

Table 2 – Comparison of Runoff Volumes

		Eq. 5	Eq. 6	TR-55	
				NRCS	
Volume Type	Current Caltrans Practice (HDM Table 819.2B)	Reese (2006) -Median-	Urbonas (1999)	Composite CN	Separated Land Use CN
Water Quality Volume	2138	2003	2003	1565	1565
Target Capture Volume	2836	1936	1530	196	1565

It is important to recognize that the composite CN used in the TR-55 method assumes that the impervious and pervious areas are homogeneously distributed throughout the drainage area. This results in an erroneously small Target Capture Volume for small, non-homogeneous drainages (196 ft^2 for this example). A more appropriate approach for highways is to analyze the land uses separately and then add the resulting runoff volumes. For the 0.62 inch of rainfall with a pervious area CN of 70 there is no runoff, therefore the Target Capture Volume for this example is the same as the WQV.

Sizing Calculations
Tri-C Manufacturing
520 Harbor Blvd, West Sacramento, CA 95691

Sizing Basis	
Capture - Double the 85th hourly intensity (in/hr)	0.2
Treatment - depth of 85%-24hr Storm Depth (in)	0.62

	Area (ft²)	Runof coefficient	Volume to Treat (gal)	Capture Rate (gpm)
Drainage 1	29,070.0	0.892	10,021.3	53.4
Drainage 2	28,330.0	0.892	9,766.2	52.1
Drainage 3 - compacted soil	9,392.5	0.6	2,177.9	11.6
Drainge 3 - impervious	20,191.0	0.892	6,960.4	37.1
DA2&DA3	57,913.5		18,904.5	100.8
Total Treatment Area	86,983.5		28,925.7	154.2

Appendix A.6 Temporal distributions of annual maxima

1. Introduction

Temporal distributions of annual maxima are provided for 6-, 12-, 24-, and 96-hour durations. The temporal distributions are expressed in probability terms as cumulative percentages of precipitation totals at various time steps. To provide detailed information on the varying temporal distributions, separate temporal distributions were also derived for four precipitation cases defined by the duration quartile in which the greatest percentage of the total precipitation occurred.

Stations were grouped into fourteen climate regions, shown in Figure A.6.1, and separate temporal distributions were derived for each climate region. Regions were delineated based on extreme precipitation characteristics expressed through 24-hour mean annual maximum (MAM) estimates, mean annual precipitation (MAP), elevation, latitude, and proximity to the coast. In some cases, transitional regions were created between very distinct climate regions.

Climate regions. Some of the highest precipitation amounts occur in region 1, where precipitation is orographically enhanced by the western facing Coastal Range Mountains as moisture-laden storms reach the shoreline. In transitional region 2 which is more inland, the elevation increases slightly, but as it is farther from the coast, precipitation amounts begin to decrease. To the south, region 7 is also influenced by the Coastal Range, but the terrain is not as varied and precipitation amounts are lower due to the stronger influence of the eastern Pacific high pressure that forces maritime storms to the north especially during the summer. Region 8 is a drier transitional region due to its leeward proximity to the Coastal Range.

Beyond these mountains, the low-lying interior Central Valley regions (5, 9 and 10) are cut off from the maritime moisture and receive much less precipitation. The more northern region 5 has relatively higher precipitation amounts than regions 9 and 10. Region 9 contains some of the lowest precipitation amounts in the state. MAP and MAM begin to increase in the transitional region 10 and then peak in the Sierra Nevada Range (regions 6 and 11). Region 6 may have lower elevations than region 11, but because it is farther north, it receives increased amounts of precipitation. In northeastern region 3, elevations remain high due to the Cascade Range and Sierra Nevada Range, but leeward characteristics relative to the moisture flow cause it to be a transitional zone into the lower precipitation amounts of region 4 which is part of North America’s Great Basin.

In the south, region 12 comprises the LA Basin encircled by a series of mountains that stretch from west to east. This region has the highest precipitation amounts in southern California. Region 13 in southwest California along the coast is flanked by mountains on its northern and eastern sides but the region is so far south that it is impacted by fewer storms. The Cascade Range, Sierra Nevada and LA Basin mountains serve to cut off moisture to eastern California forming a very dry, desert climate particularly in the southeast (region 14). However, the southeastern desert region is susceptible to the Mexican Monsoon during the summer months where tropical Pacific moisture flows up from the southwest triggering brief but heavy downpours especially at higher elevations.

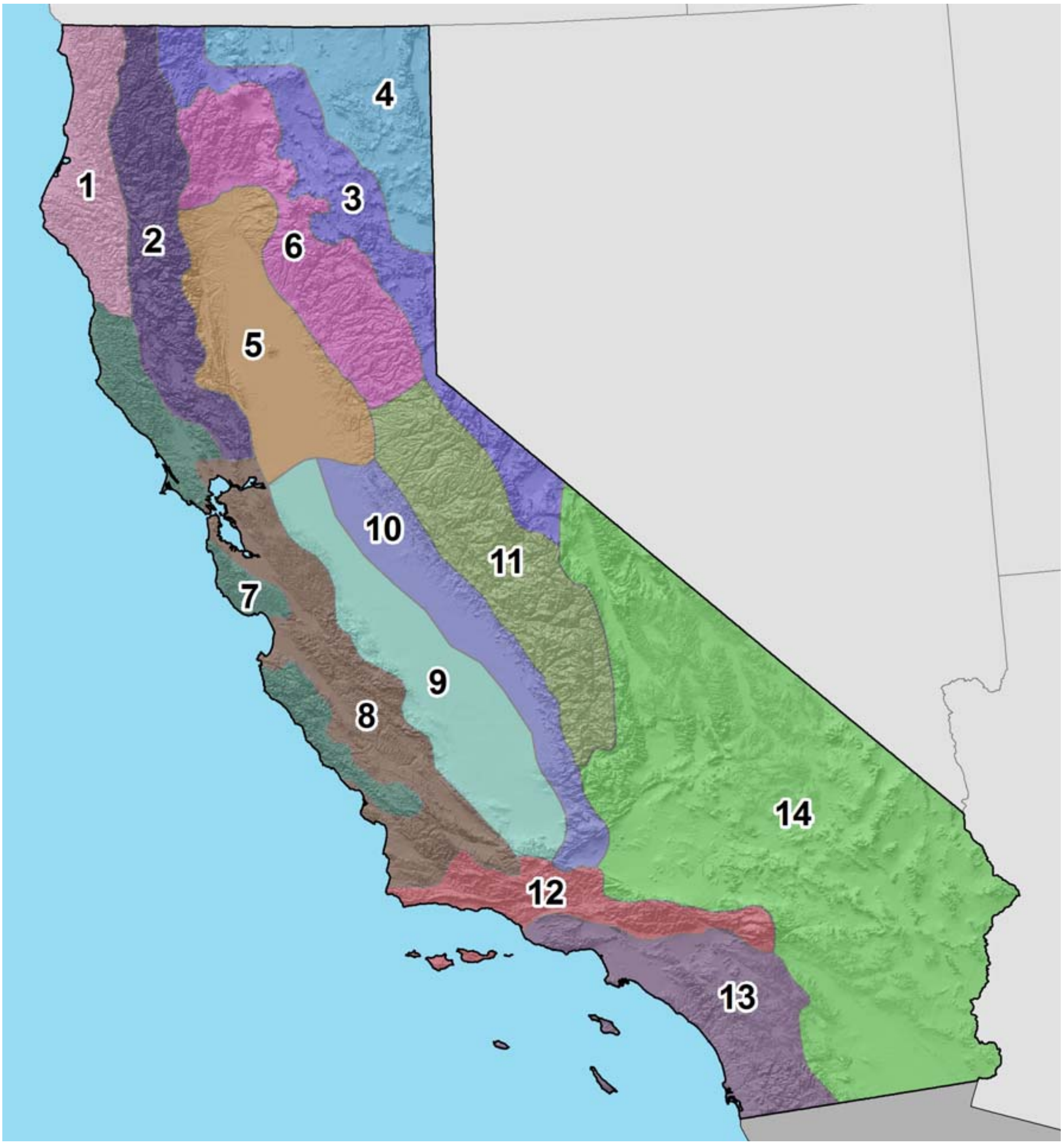


Figure A.6.1. Climate regions used for temporal distribution and seasonality analyses.

2. Methodology and results

The methodology used to produce the temporal distributions is similar to the one developed by Huff (1967) except in the definition of precipitation cases. In accordance with the way a precipitation case ('event') was defined for the precipitation frequency analysis, a precipitation case for the temporal distribution analysis was computed as the total accumulation over a specific duration (6-, 12-, 24-, or 96-hours). As a result, it may contain parts of one or more storms. Because of that, temporal distribution curves presented here may be different from corresponding temporal distribution curves obtained from the analysis of single storms.

Also, precipitation cases for this project always start with precipitation but not necessarily end with precipitation resulting in potentially more front-loaded cases when compared with distributions derived

from the single storm approach. To reduce biases, a constraint was imposed to exclude cases with a continuous dry period that lasted for more than 30% of the duration. This restriction produced a less variant sample. By imposing the restriction on continuous dry periods, the number of cases available for temporal distribution analysis decreased with duration because long, continuous precipitation events occurred less frequently than continuous short-duration events. Cases were selected from the annual maximum series at each station. Table A.6.1 shows the total number of precipitation cases and number of cases in each quartile for each region for each selected duration.

For each precipitation case, cumulative precipitation amounts were converted into percentages of the total precipitation amount at one hour time increments. All cases for a specific duration were then combined and probabilities of occurrence of precipitation totals were computed at each hour. The temporal distribution curves for nine deciles (10% to 90%) were smoothed using linear programming method (Bonta and Rao, 1988) and plotted in the same graph. Figure A.6.2 shows as an example of temporal distribution curves for the four selected durations for region 13; time steps were converted into percentages of durations for easier comparison.

The cases were further divided into four categories by the quartile in which the greatest percentage of the total precipitation occurred. Table A.6.1 shows the numbers and proportion of precipitation cases used to derive the temporal distributions in each quartile. Unlike the cases of 12-, 24-, and 96-hour durations in which the number of data points can be equally divided by four, the cases of 6-hour duration contain only six data points and they cannot be evenly distributed into four quartiles. Therefore, in this analysis, for 6-hour duration, the first quartile contains precipitation cases where the most precipitation occurred in the first hour, the second quartile contains precipitation cases where the most precipitation occurred in the second and third hours, the third quartile contains precipitation cases where the most precipitation occurred in the fourth hour, and the fourth quartile contains precipitation cases where the most precipitation occurred in the fifth and sixth hours. This uneven distribution affects the number of cases contained in each quartile for the 6-hour duration. Figures A.6.3 through A.6.6 show the temporal distribution curves for four quartile cases for 6-hour, 12-hour, 24-hour and 96-hour durations, respectively.

Table A.6.1. Total number of precipitation cases and number (and percent) of cases in each quartile for selected durations for each designated climate region.

Duration	**Region**	**All cases**	**First-quartile cases**	**Second-quartile cases**	**Third-quartile cases**	**Fourth-quartile cases**
6-hour	1	424	66 (16%)	117 (28%)	149 (35%)	92 (22%)
	2	573	80 (14%)	177 (31%)	177 (31%)	139 (24%)
	3	583	107 (18%)	182 (31%)	168 (29%)	126 (22%)
	4	274	57 (21%)	82 (30%)	91 (33%)	44 (16%)
	5	883	143 (16%)	240 (27%)	313 (35%)	187 (21%)
	6	968	173 (18%)	241 (25%)	297 (31%)	257 (27%)
	7	775	103 (13%)	224 (29%)	295 (38%)	153 (20%)
	8	1573	258 (16%)	511 (32%)	539 (34%)	265 (17%)
	9	397	71 (18%)	127 (32%)	127 (32%)	72 (18%)
	10	394	88 (22%)	121 (31%)	114 (29%)	71 (18%)
	11	884	154 (17%)	269 (30%)	253 (29%)	208 (24%)
	12	1054	121 (11%)	276 (26%)	399 (38%)	258 (24%)
	13	1880	329 (18%)	561 (30%)	627 (33%)	363 (19%)
	14	693	150 (22%)	203 (29%)	213 (31%)	127 (18%)

Duration	Region	All cases	First-quartile cases	Second-quartile cases	Third-quartile cases	Fourth-quartile cases
12-hour	1	415	86 (21%)	122 (29%)	134 (32%)	73 (18%)
	2	561	100 (18%)	152 (27%)	202 (36%)	107 (19%)
	3	557	143 (26%)	178 (32%)	164 (29%)	72 (13%)
	4	228	53 (23%)	72 (32%)	74 (32%)	29 (13%)
	5	859	159 (19%)	231 (27%)	269 (31%)	200 (23%)
	6	958	172 (18%)	260 (27%)	299 (31%)	227 (24%)
	7	735	134 (18%)	228 (31%)	233 (32%)	140 (19%)
	8	1405	290 (21%)	460 (33%)	426 (30%)	229 (16%)
	9	319	82 (26%)	113 (35%)	73 (23%)	51 (16%)
	10	370	88 (24%)	117 (32%)	95 (26%)	70 (19%)
	11	867	140 (16%)	281 (32%)	269 (31%)	177 (20%)
	12	1012	165 (16%)	324 (32%)	340 (34%)	183 (18%)
	13	1730	363 (21%)	587 (34%)	490 (28%)	290 (17%)
	14	541	129 (24%)	182 (34%)	148 (27%)	82 (15%)
24-hour	1	404	87 (22%)	128 (32%)	120 (30%)	69 (17%)
	2	546	113 (21%)	183 (34%)	146 (27%)	104 (19%)
	3	490	133 (27%)	180 (37%)	108 (22%)	69 (14%)
	4	198	65 (33%)	59 (30%)	43 (22%)	31 (16%)
	5	793	195 (25%)	195 (25%)	202 (25%)	201 (25%)
	6	930	149 (16%)	264 (28%)	300 (32%)	217 (23%)
	7	680	164 (24%)	206 (30%)	173 (25%)	137 (20%)
	8	1275	443 (35%)	339 (27%)	285 (22%)	208 (16%)
	9	254	93 (37%)	60 (24%)	72 (28%)	29 (11%)
	10	310	90 (29%)	93 (30%)	75 (24%)	52 (17%)
	11	805	190 (24%)	287 (36%)	225 (28%)	103 (13%)
	12	881	220 (25%)	276 (31%)	237 (27%)	148 (17%)
	13	1492	451 (30%)	485 (33%)	338 (23%)	218 (15%)
	14	384	137 (36%)	109 (28%)	94 (24%)	44 (11%)
96-hour	1	350	111 (32%)	91 (26%)	87 (25%)	61 (17%)
	2	425	118 (28%)	126 (30%)	101 (24%)	80 (19%)
	3	316	100 (32%)	90 (28%)	81 (26%)	45 (14%)
	4	125	38 (30%)	37 (30%)	25 (20%)	25 (20%)
	5	497	177 (36%)	120 (24%)	114 (23%)	86 (17%)
	6	681	197 (29%)	155 (23%)	178 (26%)	151 (22%)
	7	477	170 (36%)	123 (26%)	102 (21%)	82 (17%)
	8	727	265 (36%)	170 (23%)	201 (28%)	91 (13%)
	9	128	43 (34%)	27 (21%)	31 (24%)	27 (21%)
	10	134	32 (24%)	36 (27%)	35 (26%)	31 (23%)
	11	431	157 (36%)	108 (25%)	115 (27%)	51 (12%)
	12	356	123 (35%)	66 (19%)	93 (26%)	74 (21%)
	13	583	219 (38%)	106 (18%)	128 (22%)	130 (22%)
	14	95	38 (40%)	18 (19%)	22 (23%)	17 (18%)

From the Precipitation Frequency Data Server, regional temporal distribution data are available in a tabular form for a selected location under the 'Supplementary information' tab or through the temporal distribution web page (http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_temporal.html). For 6-, 12- and 24-hour durations, temporal distribution data are provided in 0.5-hour increments and for 96-hour duration in hourly increments.

3. Interpretation

Figure A.6.2 shows as an example the temporal distribution curves of all precipitation cases in region 13 for the 6-, 12-, 24-, and 96-hour durations. Time steps were converted into percentages of total durations for easier comparison. Figures A.6.3 through A.6.6 show temporal distribution curves for first-, second-, third-, and fourth-quartile cases for 6-hour, 12-hour, 24-hour and 96-hour durations, respectively. First-quartile plots show temporal distribution curves for cases where the greatest percentage of the total precipitation fell during the first quarter of the duration (e.g., the first 3 hours of a 12-hour duration). The second, third, and fourth quartile plots are similarly for cases where the most precipitation fell in the second, third, or fourth quarter of the duration.

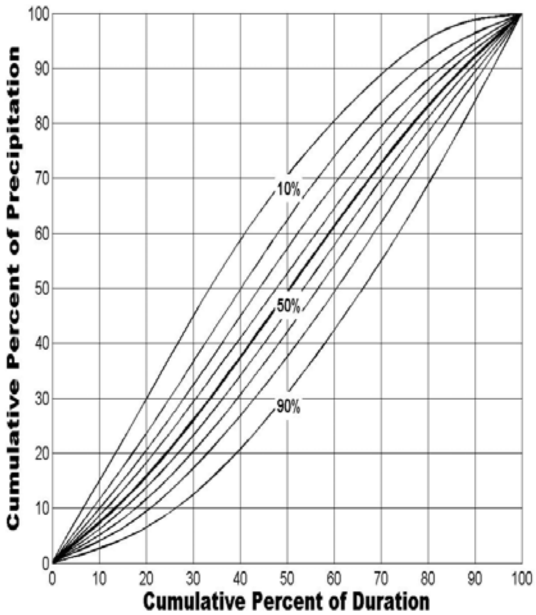
The temporal distribution curves represent the averages of many cases and illustrate the temporal distribution patterns with 10% to 90% occurrence probabilities in 10% increments. For example, the 10% curve in any figure indicates that 10% of the corresponding precipitation cases had distributions that fell above and to the left of the curve. Similarly, 10% of the cases had temporal distribution falling to the right and below the 90% curve. The 50% curve represents the median temporal distribution.

The following is an example of how to interpret the results using the figure (a) in the upper left panel of Figure A.6.5 for 24-hour first-quartile cases in region 13.

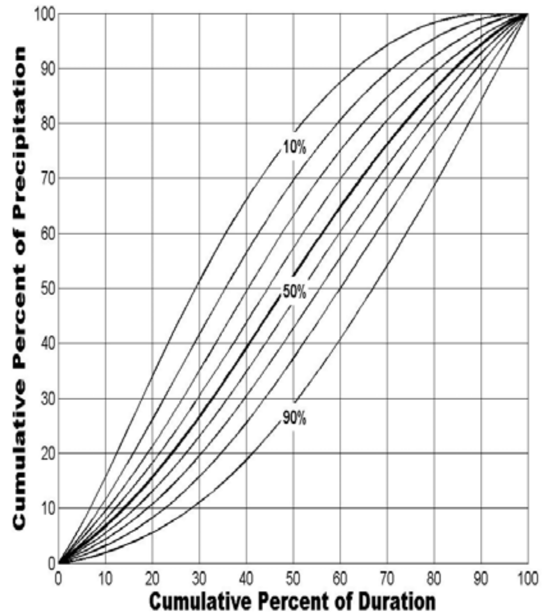
- In 10% of the first-quartile cases, 50% of the total precipitation fell in the first 4.3 hours (18% of duration) and 90% of the total precipitation fell by 12 hours (50% of duration).
- A median case of this type will drop half of the precipitation (50% on the y-axis) in approximately 6.2 hours.
- In 90% of the cases, 50% of the total precipitation fell by 10.6 hours (44% of duration) and 90% of precipitation fell by 22 hours (92% of duration).

Temporal distribution curves are provided in order to show the range of possibilities. Care should be taken in the interpretation and use of temporal distribution curves. For example, the use of different temporal distribution data in hydrologic models may result in very different peak flow estimates. Therefore, they should be selected and used in a way to reflect users' objectives.

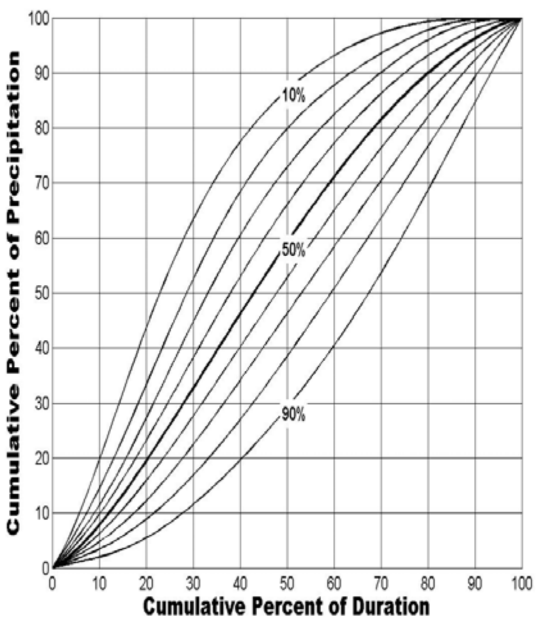
a) 6-hour duration



b) 12-hour duration



c) 24-hour duration



d) 96-hour duration

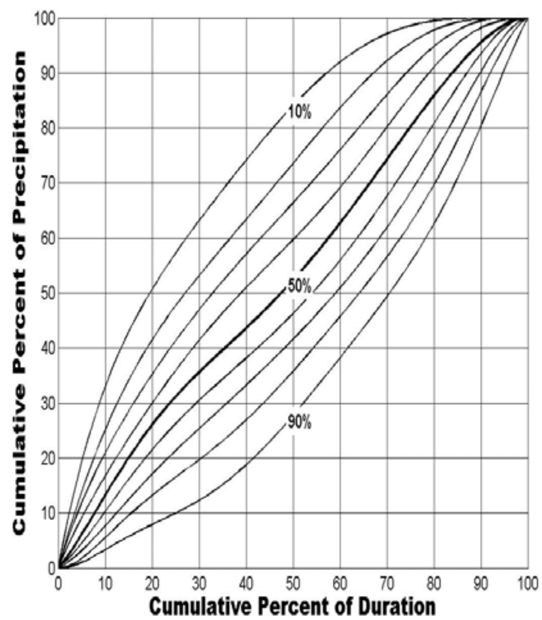
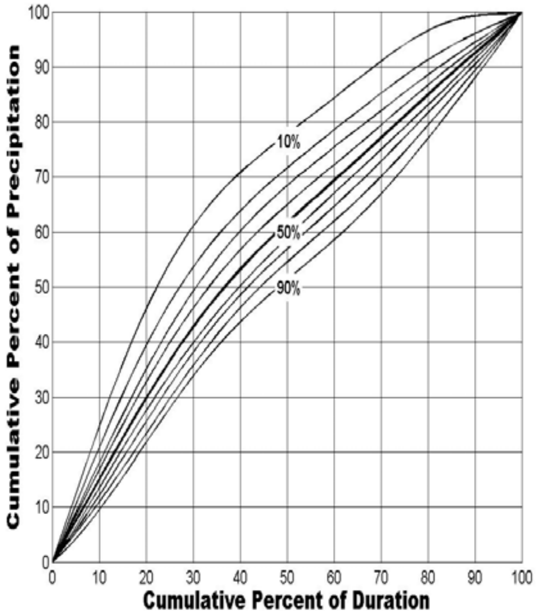
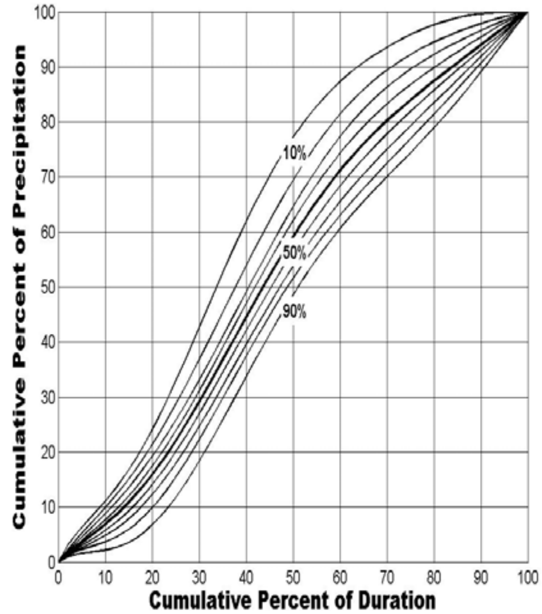


Figure A.6.2. Temporal distribution curves for region 13 all cases for: a) 6-hour, b) 12-hour, c) 24-hour, and d) 96-hour durations.

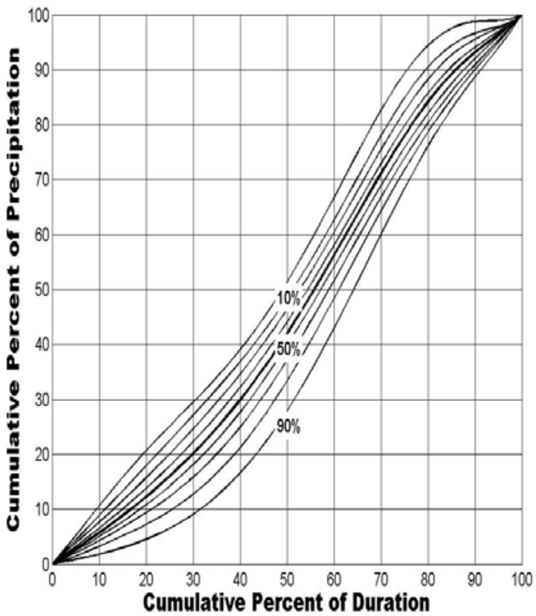
a) First-quartile



b) Second-quartile



c) Third-quartile



d) Fourth-quartile

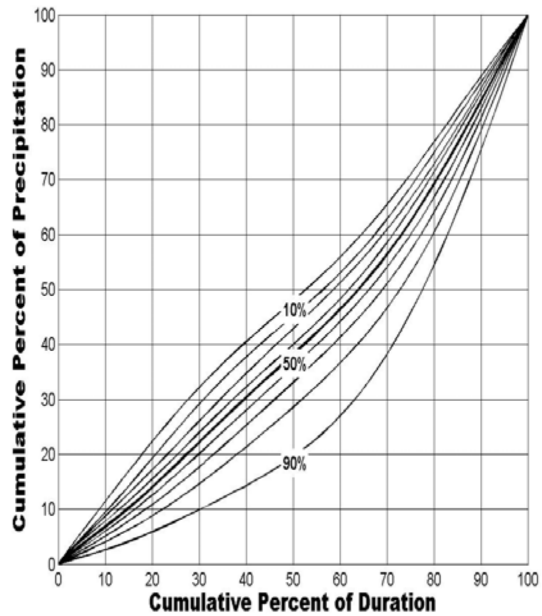


Figure A.6.3. 6-hour temporal distribution curves for region 13: a) first-quartile, b) second-quartile, c) third-quartile, and d) fourth-quartile cases.

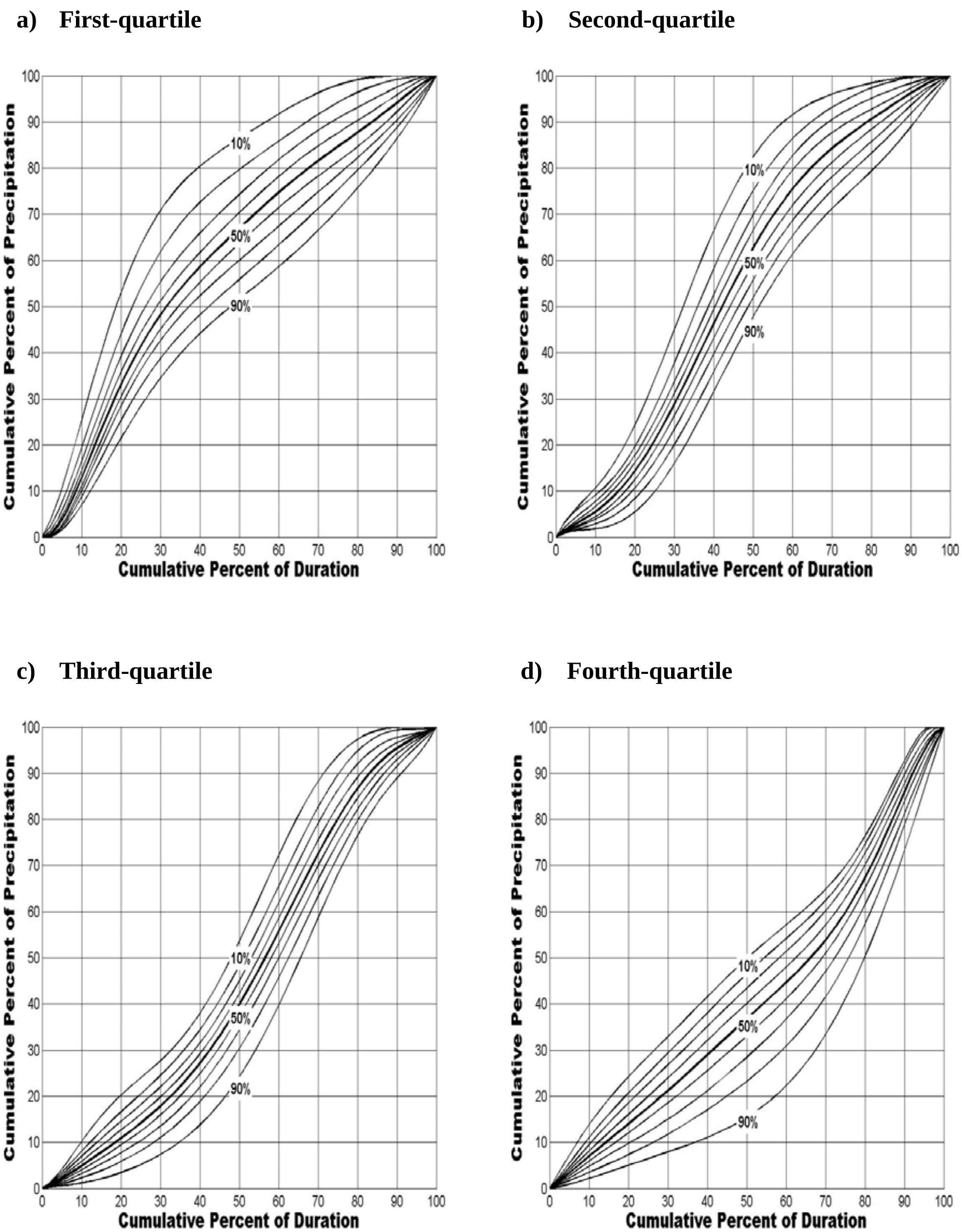
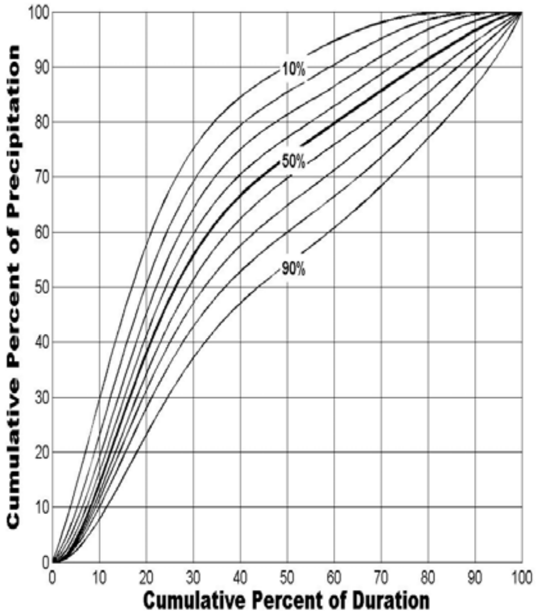
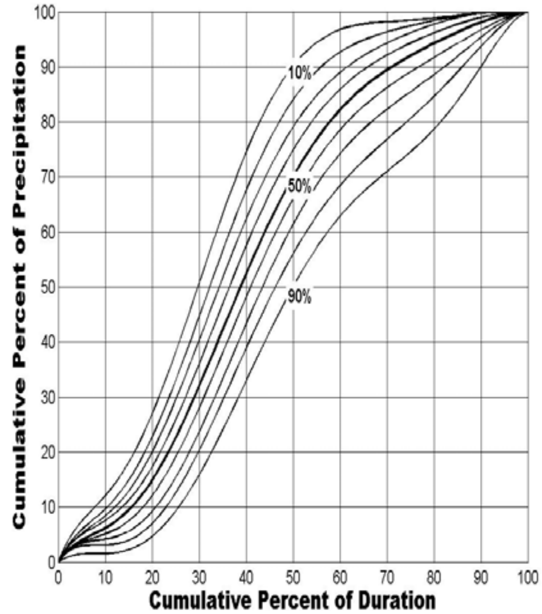


Figure A.6.4. 12-hour temporal distribution curves for region 13: a) first-quartile, b) second-quartile, c) third-quartile, and d) fourth-quartile cases.

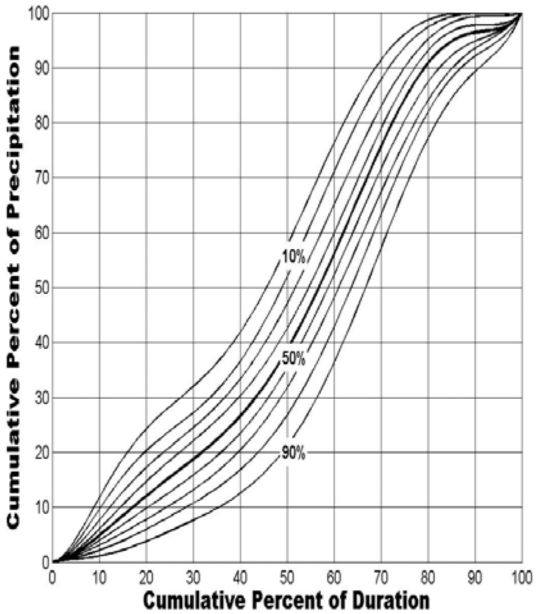
a) First-quartile



b) Second-quartile



c) Third-quartile



d) Fourth-quartile

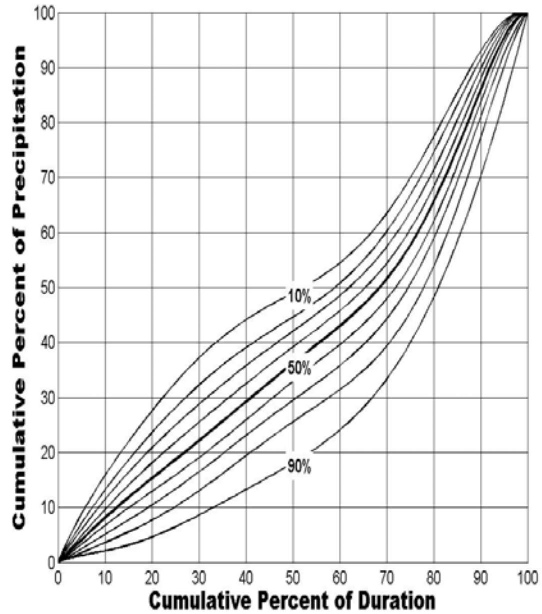


Figure A.6.5. 24-hour temporal distribution curves for region 13: a) first-quartile, b) second-quartile, c) third-quartile, and d) fourth-quartile cases.

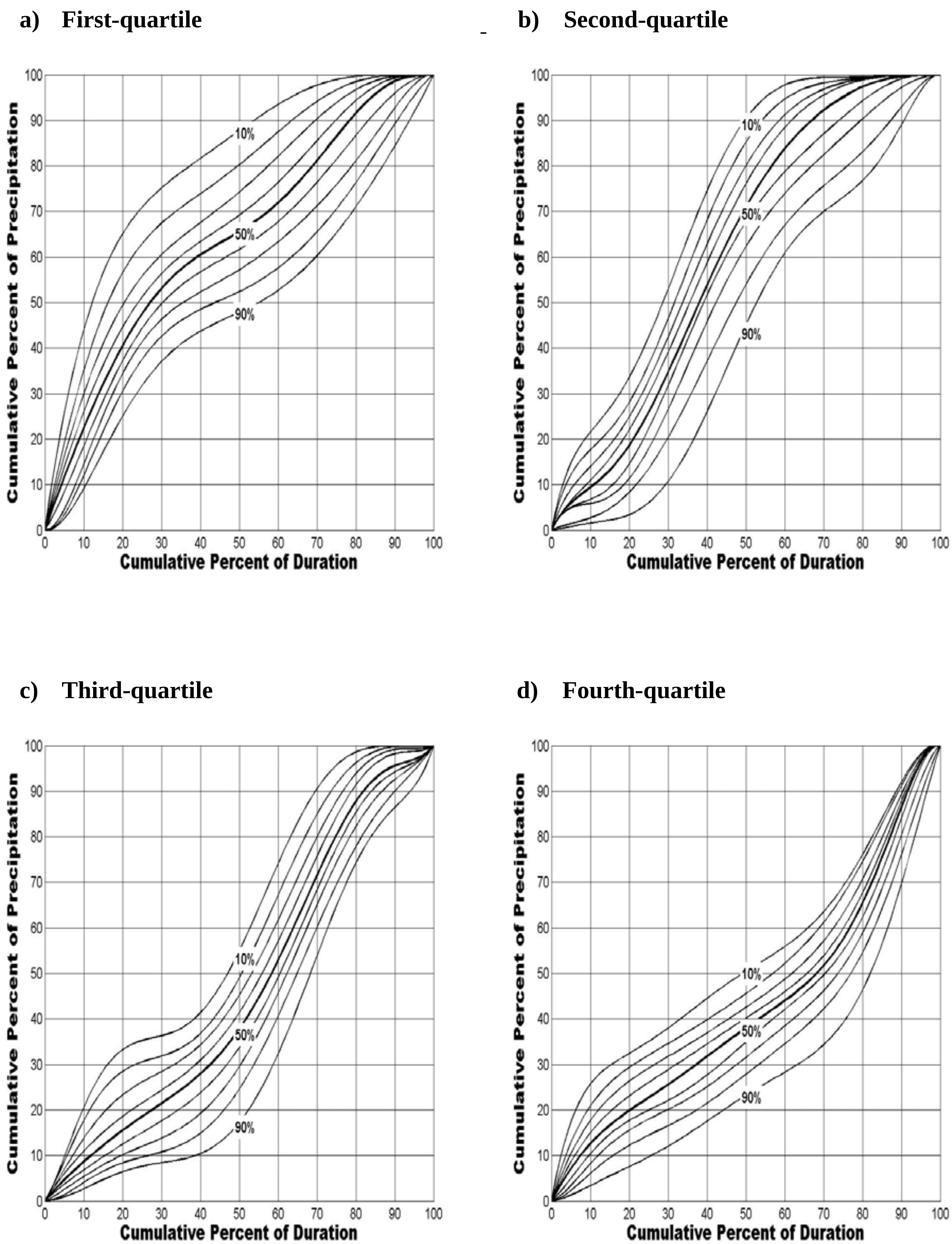
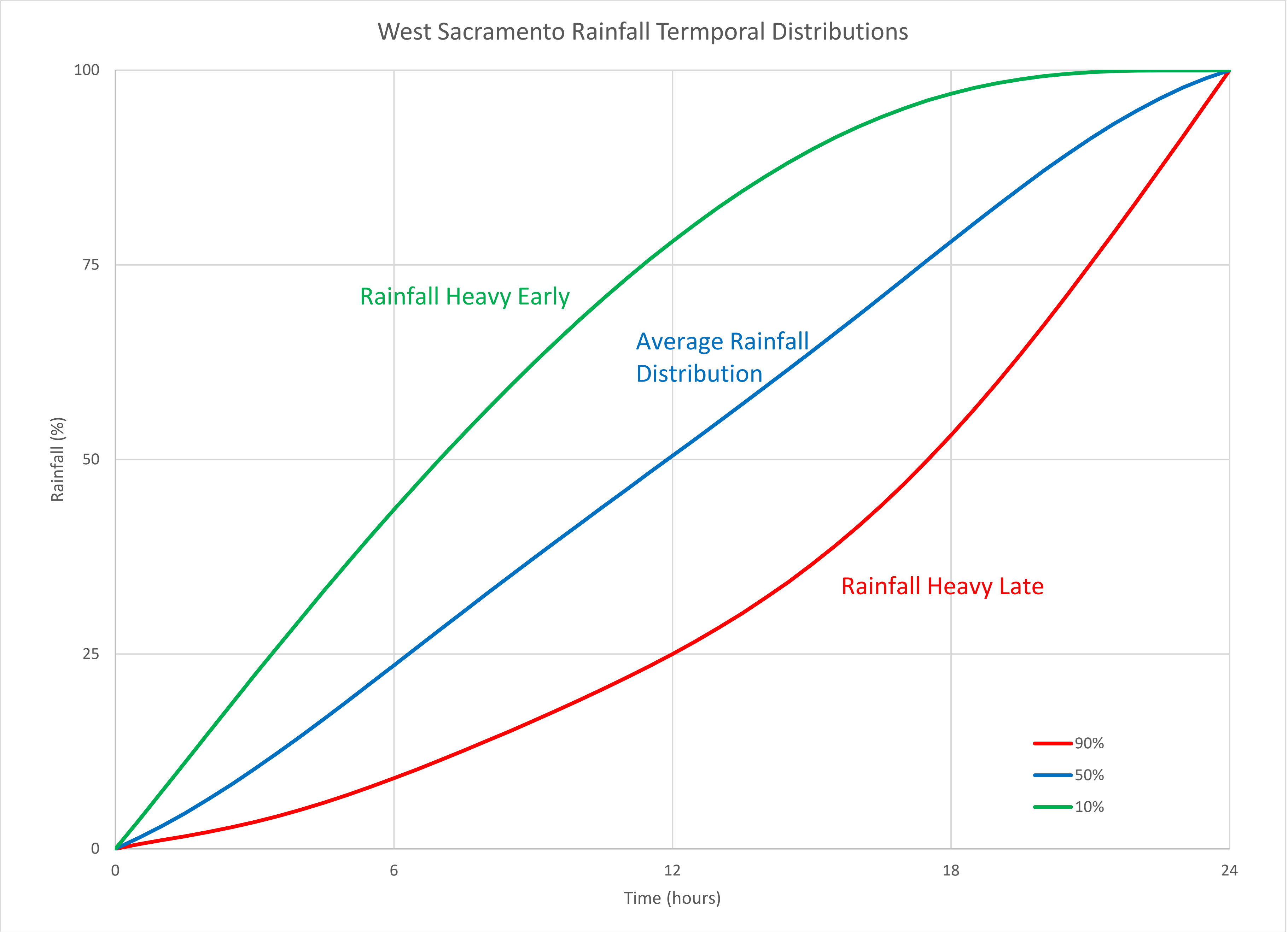
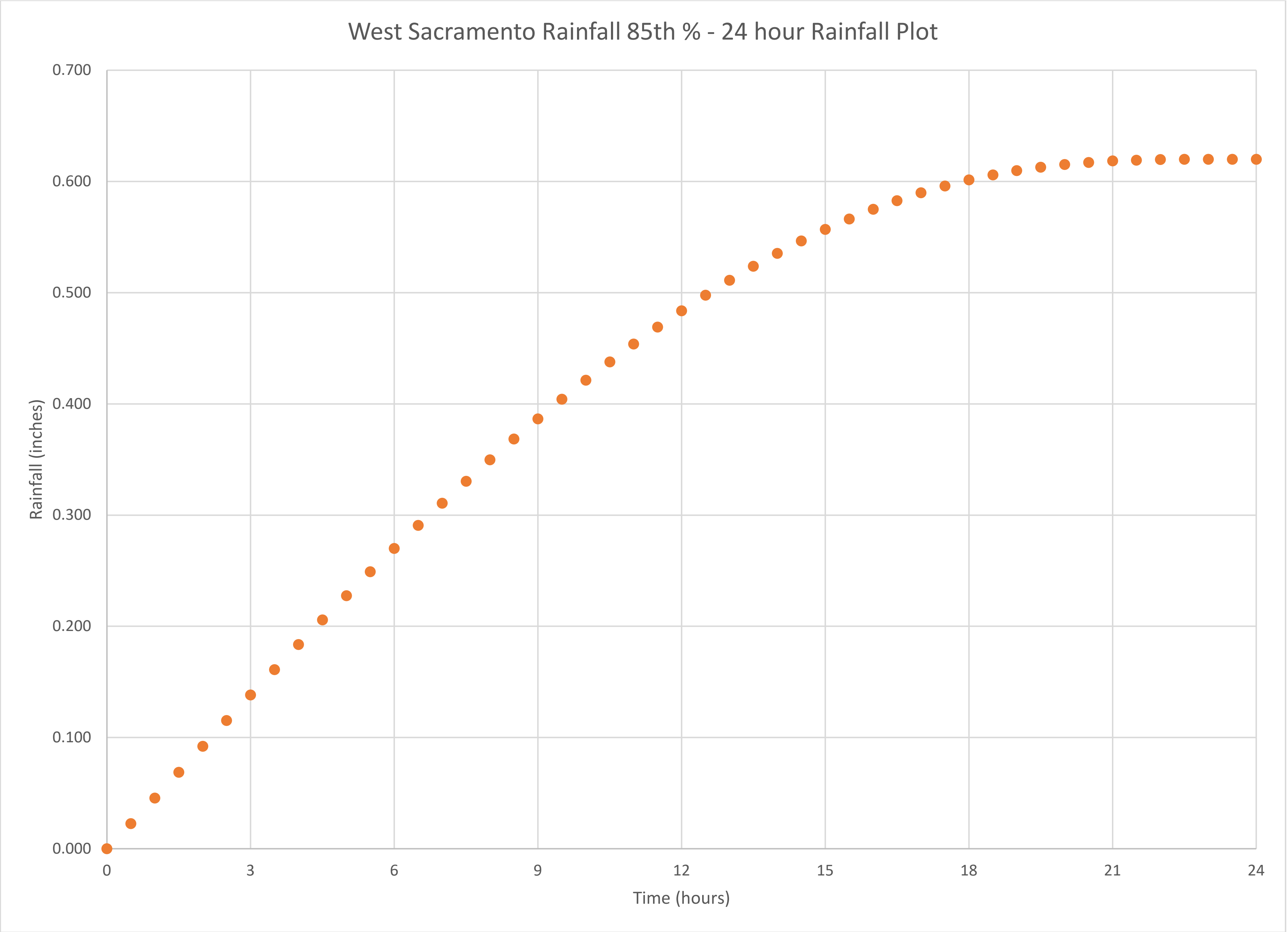


Figure A.6.6. 96-hour temporal distribution curves for region 13: a) first-quartile, b) second-quartile, c) third-quartile, and d) fourth-quartile cases.

NOAA Temporal Distribution Data
California Region 5

Time	90%	50%	10%
0.00	0.00	0.00	0.00
0.50	0.58	1.39	3.65
1.00	1.10	2.92	7.36
1.50	1.62	4.58	11.10
2.00	2.16	6.36	14.85
2.50	2.77	8.26	18.59
3.00	3.44	10.26	22.30
3.50	4.20	12.35	25.98
4.00	5.03	14.51	29.61
4.50	5.94	16.72	33.19
5.00	6.92	18.98	36.71
5.50	7.96	21.27	40.17
6.00	9.06	23.57	43.56
6.50	10.20	25.88	46.88
7.00	11.38	28.18	50.12
7.50	12.60	30.48	53.30
8.00	13.85	32.76	56.39
8.50	15.12	35.03	59.41
9.00	16.42	37.27	62.34
9.50	17.75	39.50	65.19
10.00	19.11	41.71	67.95
10.50	20.51	43.91	70.61
11.00	21.95	46.10	73.18
11.50	23.45	48.29	75.65
12.00	25.02	50.47	78.02
12.50	26.67	52.66	80.28
13.00	28.41	54.87	82.43
13.50	30.25	57.09	84.46
14.00	32.21	59.33	86.36
14.50	34.29	61.59	88.15
15.00	36.52	63.88	89.81
15.50	38.89	66.20	91.34
16.00	41.41	68.53	92.73
16.50	44.10	70.88	93.99
17.00	46.94	73.25	95.12
17.50	49.95	75.62	96.12
18.00	53.12	77.98	96.99
18.50	56.45	80.33	97.73
19.00	59.92	82.64	98.34
19.50	63.54	84.90	98.84
20.00	67.27	87.09	99.24
20.50	71.12	89.20	99.53
21.00	75.07	91.20	99.74
21.50	79.10	93.08	99.87
22.00	83.19	94.81	99.95
22.50	87.34	96.38	99.98
23.00	91.53	97.78	99.98
23.50	95.75	98.99	99.98
24.00	100.00	100.00	100.00

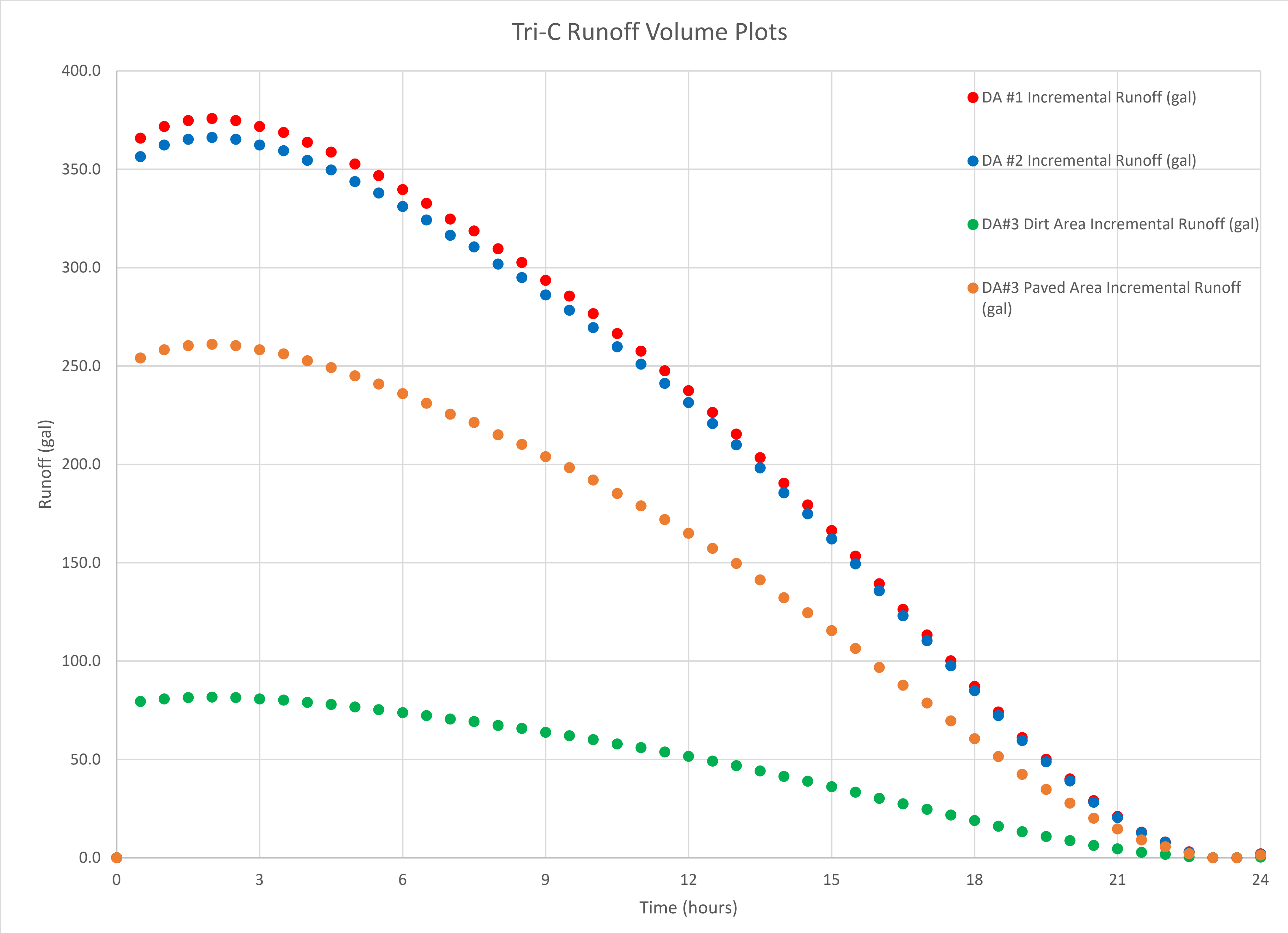

West Sacramento Rainfall Termporal Distributions
100
75
50
25
0
Rainfall (%)
0
6
12
18
24
Time (hours)
Rainfall Heavy Early
Average Rainfall
Distribution
Rainfall Heavy Late
90%
50%
10%

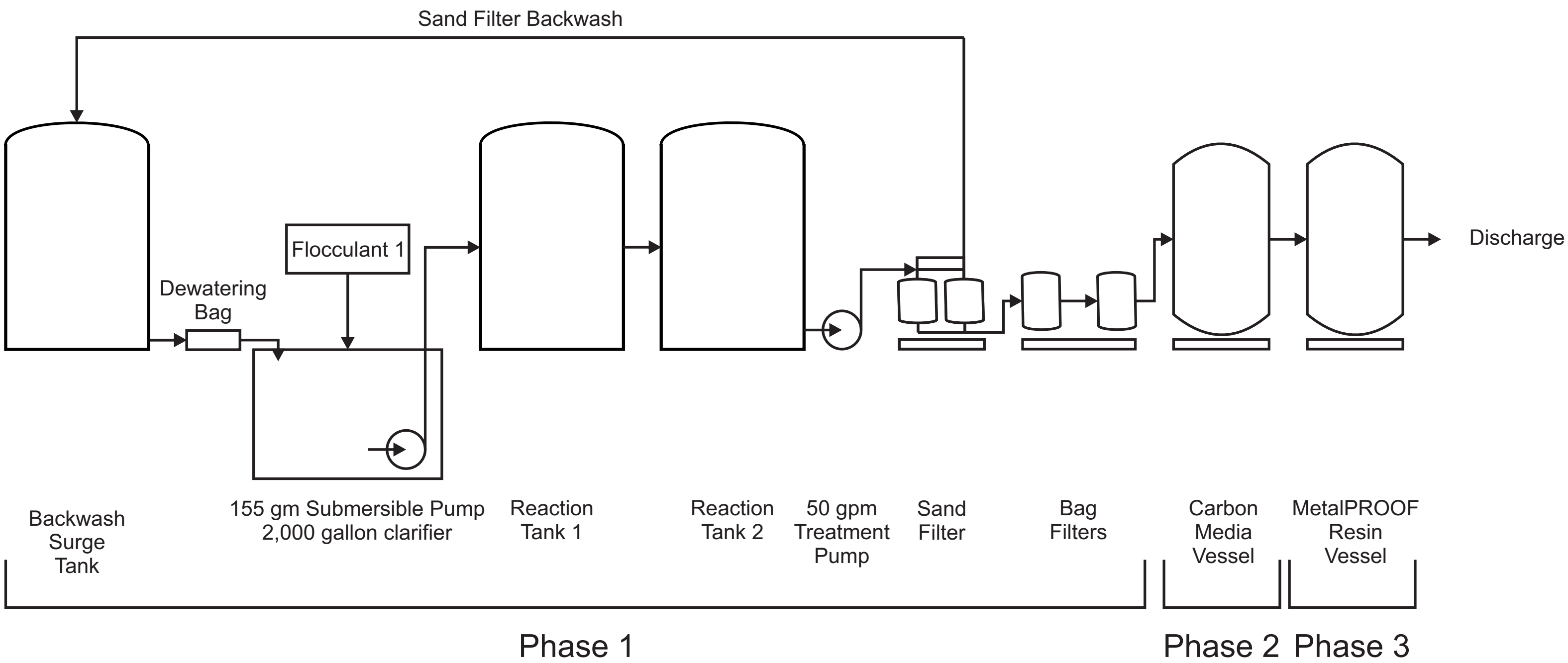

West Sacramento Rainfall 85th % - 24 hour Rainfall Plot
Rainfall (inches)
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0
3
6
9
12
15
18
21
24
Time (hours)

Treatment Simulation
Tri-C Manufacturing
520 Harbor Blvd, West Sacramento, CA 95691

Termporal Distribution Region	DA#1 (acres)	DA#2 (acres)	Fraction Paved	Runoff Coefficient	DA#3 Dirt (acres)	DA#3 Dirt Runoff Coefficient	DA#3 Paved (acres)	85th % 24 hr storm depth (in) From CalTrans
5	0.67	0.65	1.00	0.892	0.216	0.6	0.464	0.62

Time (hours)	10%	Rainfall (in)	Incremental Rain (in)	DA #1 Incremental Runoff (gal)	DA# 1 Sump Volume (gal)	DA#1 Sump Pump Max Rate (gpm)	DA#1 Sump Pump Vol (gal)	DA #2 Incremental Runoff (gal)	DA#3 Dirt Area Incremental Runoff (gal)	DA#3 Paved Area Incremental Runoff (gal)	DA#2 / DA#3 Sump Volume (gal)	DA#2/DA#3 Sump Pump Max Rate (gpm)	DA#2 / DA#3 Sump Pump Vol (gal)	Combined Runoff (gal)	Clarifier Volume (gal)	Clarfier Sump Pump Max Rate (gpm)	Clarifier Sump Pump Vol (gal)	Above-ground tank Volume (gal)	Treatment Max Rate (gpm)	Treatment Volume (gal)
0	0	0.000	0	0.0	0	55	0	0.0	0	0	0	0	0	0	0	0	0	0	50	0
0.5	3.65	0.023	0.02263	366	366	55	366	356	79	254	690	105	690	1056	1056	155	1056	1056	50	1056
1	7.36	0.046	0.02300	372	372	55	372	362	81	258	701	105	701	1073	1073	155	1073	1073	50	1073
1.5	11.1	0.069	0.02319	375	375	55	375	365	81	260	707	105	707	1082	1082	155	1082	1082	50	1082
2	14.85	0.092	0.02325	376	376	55	376	366	82	261	709	105	709	1085	1085	155	1085	1085	50	1085
2.5	18.59	0.115	0.02319	375	375	55	375	365	81	260	707	105	707	1082	1082	155	1082	1082	50	1082
3	22.3	0.138	0.02300	372	372	55	372	362	81	258	701	105	701	1073	1073	155	1073	1073	50	1073
3.5	25.98	0.161	0.02282	369	369	55	369	359	80	256	696	105	696	1064	1064	155	1064	1064	50	1064
4	29.61	0.184	0.02251	364	364	55	364	355	79	253	686	105	686	1050	1050	155	1050	1050	50	1050
4.5	33.19	0.206	0.02220	359	359	55	359	350	78	249	677	105	677	1036	1036	155	1036	1036	50	1036
5	36.71	0.228	0.02182	353	353	55	353	344	77	245	665	105	665	1018	1018	155	1018	1018	50	1018
5.5	40.17	0.249	0.02145	347	347	55	347	338	75	241	654	105	654	1001	1001	155	1001	1001	50	1001
6	43.56	0.270	0.02102	340	340	55	340	331	74	236	641	105	641	981	981	155	981	981	50	981
6.5	46.88	0.291	0.02058	333	333	55	333	324	72	231	628	105	628	960	960	155	960	960	50	960
7	50.12	0.311	0.02009	325	325	55	325	316	71	226	613	105	613	937	937	155	937	937	50	937
7.5	53.3	0.330	0.01972	319	319	55	319	311	69	221	601	105	601	920	920	155	920	920	50	920
8	56.39	0.350	0.01916	310	310	55	310	302	67	215	584	105	584	894	894	155	894	894	50	894
8.5	59.41	0.368	0.01872	303	303	55	303	295	66	210	571	105	571	874	874	155	874	874	50	874
9	62.34	0.387	0.01817	294	294	55	294	286	64	204	554	105	554	848	848	155	848	848	50	848
9.5	65.19	0.404	0.01767	286	286	55	286	278	62	198	539	105	539	824	824	155	824	824	50	824
10	67.95	0.421	0.01711	277	277	55	277	270	60	192	522	105	522	798	798	155	798	798	50	798
10.5	70.61	0.438	0.01649	267	267	55	267	260	58	185	503	105	503	769	769	155	769	769	50	769
11	73.18	0.454	0.01593	258	258	55	258	251	56	179	486	105	486	743	743	155	743	743	50	743
11.5	75.65	0.469	0.01531	248	248	55	248	241	54	172	467	105	467	714	714	155	714	714	50	714
12	78.02	0.484	0.01469	238	238	55	238	231	52	165	448	105	448	686	686	155	686	686	50	686
12.5	80.28	0.498	0.01401	226	226	55	226	221	49	157	427	105	427	654	654	155	654	654	50	654
13	82.43	0.511	0.01333	215	215	55	215	210	47	150	406	105	406	622	622	155	622	622	50	622
13.5	84.46	0.524	0.01259	203	203	55	203	198	44	141	384	105	384	587	587	155	587	587	50	587
14	86.36	0.535	0.01178	190	190	55	190	186	41	132	359	105	359	550	550	155	550	550	50	550
14.5	88.15	0.547	0.01110	179	179	55	179	175	39	125	338	105	338	518	518	155	518	518	50	518
15	89.81	0.557	0.01029	166	166	55	166	162	36	116	314	105	0	480	166	155	0	0	50	0
15.5	91.34	0.566	0.00949	153	153	55	0	149	33	106	603	105	603	443	769	155	769	769	50	769
16	92.73	0.575	0.00862	139	293	55	293	136	30	97	263	105	0	402	293	155	0	0	50	0
16.5	93.99	0.583	0.00781	126	126	55	0	123	27	88	501	105	501	364	794	155	794	794	50	794
17	95.12	0.590	0.00701	113	240	55	240	110	25	79	214	105	0	327	240	155	0	0	50	0
17.5	96.12	0.596	0.00620	100	100	55	0	98	22	70	403	105	403	289	642	155	642	642	50	642
18	96.99	0.601	0.00539	87	187	55	187	85	19	61	164	105	0	252	187	155	0	0	50	0
18.5	97.73	0.606	0.00459	74	74	55	0	72	16	52	304	105	0	214	187	155	0	0	50	0
19	98.34	0.610	0.00378	61	135	55	0	60	13	42	420	105	420	176	607	155	607	607	50	607
19.5	98.84	0.613	0.00310	50	185	55	185	49	11	35	95	105	0	145	185	155	0	0	50	0
20	99.24	0.615	0.00248	40	40	55	0	39	9	28	170	105	0	116	185	155	0	0	50	0
20.5	99.53	0.617	0.00180	29	69	55	0	28	6	20	225	105	0	84	185	155	0	0	50	0
21	99.74	0.618	0.00130	21	90	55	0	21	5	15	265	105	0	61	185	155	0	0	50	0
21.5	99.87	0.619	0.00081	13	103	55	0	13	3	9	289	105	0	38	185	155	0	0	50	0
22	99.95	0.620	0.00050	8	111	55	0	8	2	6	304	105	0	23	185	155	0	0	50	0
22.5	99.98	0.620	0.00019	3	114	55	0	3	1	2	310	105	0	9	185	155	0	0	50	0
23	99.98	0.620	0.00000	0	114	55	0	0	0	0	310	105	0	0	185	155	0	0	50	0
23.5	99.98	0.620	0.00000	0	114	55	0	0	0	0	310	105	0	0	185	155	0	0	50	0
24	100	0.620	0.00012	2	116	55	0	2	0	1	314	105	0	6	185	155	0	0	50	0
					376		**9,905**				**709**		**18,591**	**28,926**	**1085**		**28,310**	**1085**		**28,310**
					Max Sump Vol (gpm)		**Total Sump Pump Vol (gal)**				**Max Sump Vol (gpm)**		**Total Sump Pump Vol (gal)**	**Total Runoff (gal)**	**Max Clarifier Vol (gpm)**		**Total Sump Pump Vol (gal)**	**Max Tank Vol (gpm)**	**Treatment Rate (gpm)**	**Total Treated Volume (gal)**


Tri-C Runoff Volume Plots
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Runoff (gal)
0
3
6
9
12
15
18
21
24
Time (hours)
DA #1 Incremental Runoff (gal)
DA #2 Incremental Runoff (gal)
DA#3 Dirt Area Incremental Runoff (gal)
DA#3 Paved Area Incremental Runoff (gal)



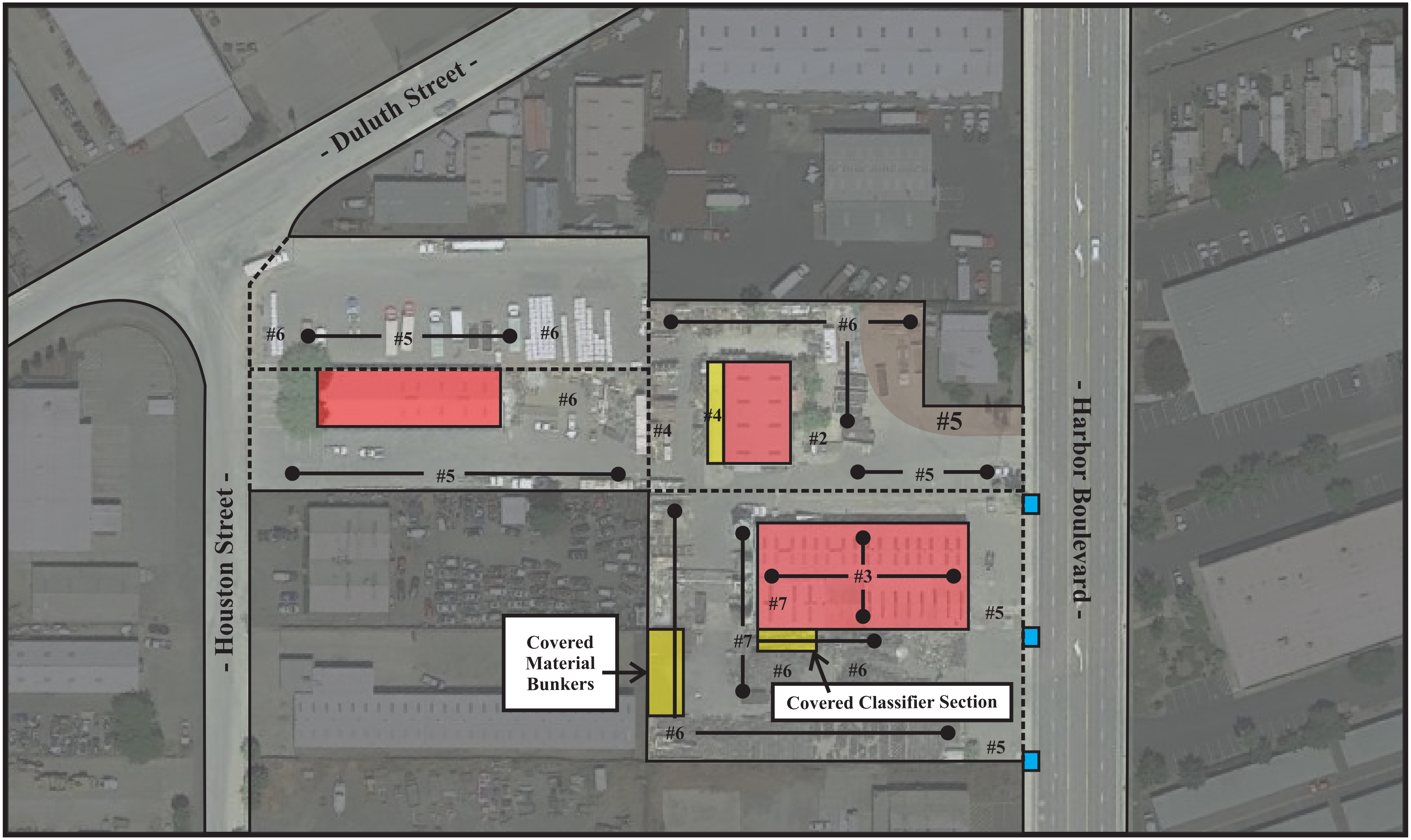
This diagram is confidential and proprietary information of Storm Water Systems.

FROG ENVIRONMENTAL | StormPROOF

Client: **Tri C Manufacturing Inc** **520 Harbor Blvd** **West Sacramento, CA 95691**	**Scale: Not to Scale** **Date: 07/15/2020**
Process Flow Diagram	**Rev: 0**

EXHIBIT B

Tri-C Manufacturing - Potential Pollutant Diagram
520 Harbor Boulevard, West Sacramento, CA 95691



FROG ENVIRONMENTAL
Your Cleaner Business is Our Environment

#1 - Indoor Maintenance Area
#2 - Outdoor Maintenance Area
#3 - Indoor Production
#4 - Hazardous Materials
#5 - Vehicle Parking
#6 - Outdoor Storage
#7 - Facility Support Equipment
#8 - Operational Equipment*

*Although not shown, the Operational Equipment is used throughout the facility.

N